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Improved Eighteen-inch Engine Lathe.

The accompanying illustration is of an 18-inch engine lathe possessing some special and noteworthy features.

Under the live spindle, and parallel with it, is a shaft on which are placed all the change gears for screw-cutting. These gears are of steel and are all keyed to the shaft which runs in substantial bearings. Changes for the different pitches in screw-cutting are made by simply changing the position of the lever seen in front of the head-stock, the entire range of screws from 2 to 32 per inch, including 11½, being cut without the removal or change of a gear wheel.

The same train of gears drives the feed rod, which thus gives feeds from 4 to 80 per inch; any rate being instantly available by the movement of the lever. The change gears are, of course, entirely out of the way, they remain clean and in good order, and cannot be lost.

The cross-feed screw is so arranged that it cuts spirals which are equal in pitch to the screws cut with the lever in corresponding position; thus scrolls for chucks, or for other purposes, or new jaws for scroll chucks can be readily made.

There is also on this lathe a device by which the tool is withdrawn ½ inch very quickly and independently of the cross feed screw. This device is connected with a carriage reverse mechanism, by which the carriage is automatically reversed by the act of withdrawing the tool, and cuts can be set independently by the cross feed; which is graduated for that purpose.

This not only enables the tool to be quickly withdrawn at the end of a cut in chasing screws, but it can also be used when turning a number of duplicate pieces, where the tool must be withdrawn at the end of the cut; as it enables the workman to instantly restore it to its former setting without moving the cross feed screw.

Neither the screw nor the rod-feed can be thrown in while the other is in action.

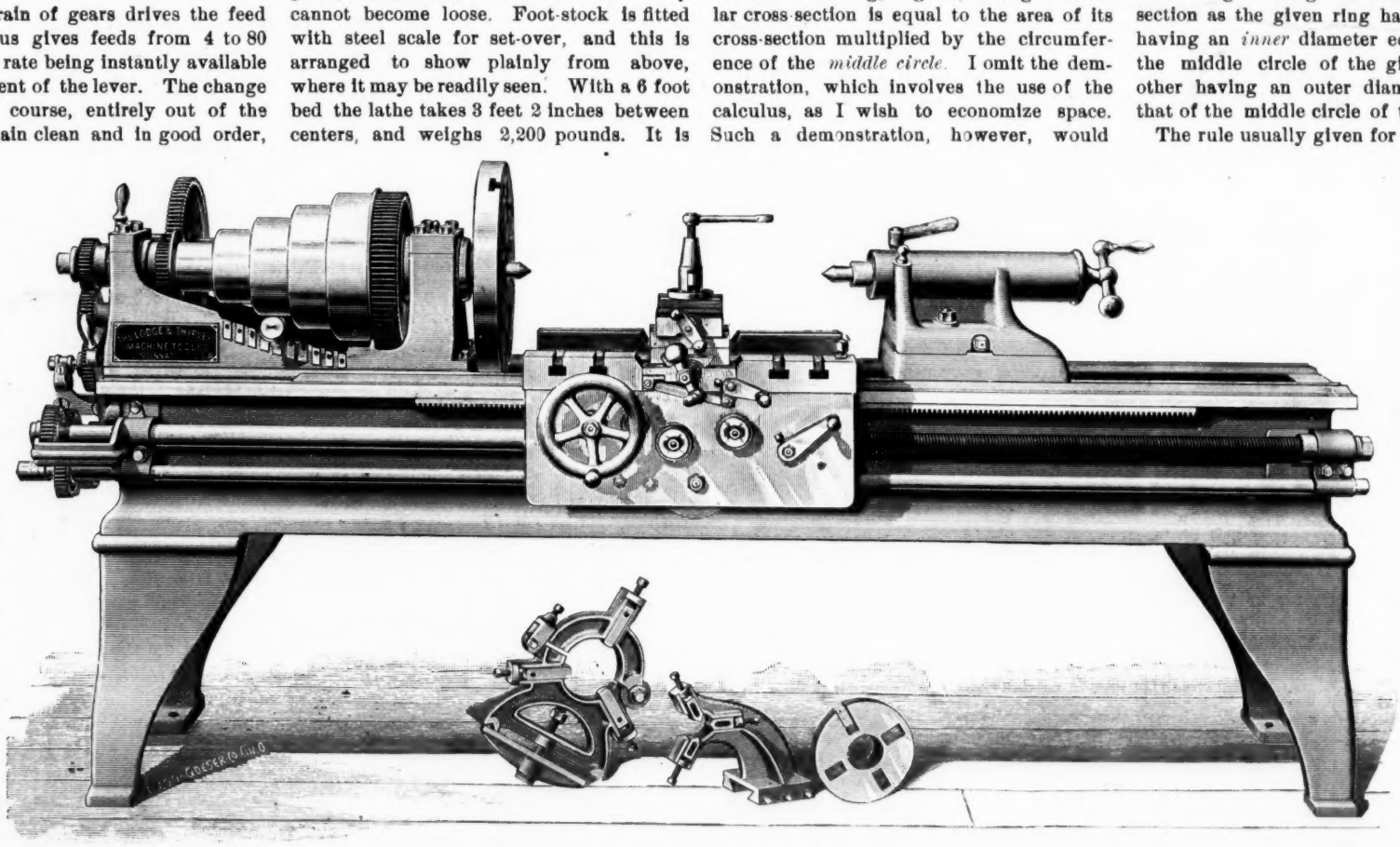
The cross-feed screw is graduated to read in 64ths or .001 inch as may be preferred, and the wheel which moves the carriage is also graduated to read to 32ds, so that distances from shoulder or depths of holes may be readily and accurately indicated without the use of a rule.

All the feed mechanism is thrown out of action by slipping the gear on the end of spindle outwards.

The cone pulley has five steps for a 2½ belt, the largest step being 12 inches diameter. Lathe is geared in ratio of 12 to 1. Front bearing is 3x4½ inches, back bearing $2\frac{5}{16}$x3½ inches. Spindle is of steel, has its bearings finished by grinding, and has a hole through it $1\frac{5}{16}$ inches diameter.

Carriage has a long bearing upon the bed, is gibbed to it, and is provided with a lock for use in facing cuts.

A plain or compound rest is furnished as may be preferred, and both are fitted with taper gibs. Racks are of steel, are in one piece, and fitted into a recess so that they cannot become loose. Foot-stock is fitted with steel scale for set-over, and this is arranged to show plainly from above, where it may be readily seen. With a 6 foot bed the lathe takes 3 feet 2 inches between centers, and weighs 2,200 pounds. It is made by The Lodge & Shipley Machine Tool Co., Cincinnati, O.



IMPROVED EIGHTEEN-INCH ENGINE LATHE.

Arithmetic of the Screw and of Symmetrical Rings—V.

BY LEICESTER ALLEN

It is now proposed to obtain general rules instead of special ones, such as were given in former articles. As the discussion will require reference to Fig. 18 of my previous article, it is here reproduced for more convenient reference.

I will first discuss the subject algebraically to show the basis of the simple arithmetical rules that will be given, and to avoid repetition, I request that those who may be interested enough to read the present article, will carefully re-peruse in this connection the remarks contained in the four concluding paragraphs in my previous article (IV.), printed in issue of June 21st.

For convenience, let us call a circle shown in dotted outline in Fig. 18 (page 2) and other subsequent figures, and drawn midway between the outer and inner circumferences of a symmetrical ring (*c d* and *c' d'* being projections of this line) the *middle circle*, to distinguish it from the outer and inner circumferences of the ring; and let us also use the following notation:

A = area of the cross-section of the ring.

R = radius of the inner circumference.

r = radius of the cross-section or, more generally, the half-difference between the radii of the outer and inner circumferences.

π = ratio of the diameter to circumference of a circle = 3.1416.

It can be proved analytically that the content of a ring, Fig. 18, having a circular cross-section is equal to the area of its cross-section multiplied by the circumference of the *middle circle*. I omit the demonstration, which involves the use of the calculus, as I wish to economize space. Such a demonstration, however, would show the proposition to be true, not only for rings of circular cross-section, but for circular rings *having any cross section* whatever symmetrical with the middle circle.

For a circular ring we may, therefore, write,

$$2\,A\,\pi\,R + 2\,A\,\pi\,r = C \qquad (1)$$

in which C = content of a given ring of any cross section symmetrical with the middle circle. We may also write,

$$2\,A\,\pi\,R + 4\,A\,\pi\,r = C' \qquad (2)$$

in which C' = content of a ring having an equal and similar cross section, but whose *inner diameter is equal to that of the middle circle.*

Again we may write,

$$2\,A\,\pi\,R = C'' \qquad (3)$$

wherein C'' = content of a ring having an equal and similar cross-section, but whose *outer diameter is equal to that of the middle circle.*

Arranging the first members of these equations in a series, we have,

$$(2\,A\,\pi\,R + 4\,A\,\pi\,r),\ (2\,A\,\pi\,R + 2\,A\,\pi\,r),\ (2\,A\,\pi\,R),$$

from which it is at once seen that the series is an arithmetical progression; that $(2\,A\,\pi\,R + 2\,A\,\pi\,r)$ is an arithmetical mean between the first and third terms, and that the common difference is $2\,A\,\pi\,r$.

This being true of the first members of the equations, it is true also of the second members. Hence, C, C', C'' constitute an arithmetical progression, having the common difference $A\,\pi\,r$.

That is to say, the content of any given ring whose cross section, as referred to the middle circle, is symmetrical, is an arithmetical mean between the contents of two other rings having each the same cross-section as the given ring has, one of them having an *inner* diameter equal to that of the middle circle of the given ring, the other having an outer diameter equal to that of the middle circle of the given ring.

The rule usually given for computing the content of a circular ring having a circular cross-section is as follows:

Rule XI.—Multiply the area of the cross-section by the circumference of the middle circle; the result will be the content sought.

I have stated that this is general for any circular ring having any form of cross section rectangular, triangular, rhomboidal, polygonal, circular or elliptical, provided it be symmetrical with the middle circle, and this would be readily inferred from the relations expressed in equations (1), (2) and (3); because it can easily be seen that the middle circle is the arithmetical mean of the outer and inner circumferences.

It is also easily perceived that the part of such a ring lying outside of the middle circle is greater than that lying within the middle circle, and as it has been previously shown that an exterior screw thread is equal to the *outer part* of the ring, whose outer and inner parts have the same cross-section, and whose middle circle is equal to the circumference of the barrel of the screw, and that the interspace is equal to the *inner part* of a ring of the same cross section, whose middle circle is equal to the circumference of the screw over all, we may derive from these principles general rules for computing any form of screw thread or bodies of helical form which are symmetrical with a helical axis, as a coiled spring, a pipe coil, etc.

Though we are here concerned chiefly with screw threads and rings, I will venture to give a rule for computing a symmetrical solid having a helical form, as it is so closely allied to the subject under discussion.

Rule XII.—To find the content of a helical solid body having a cross-section whose inner and outer parts are symmetrical with the middle helix:

Multiply together the area of the cross-section made in a plane coincident with the axis of the helix, the length of the middle circle of a ring of the same diameter, and the number of turns or winds in the coil. The result will be the solid content of the helix.

Example.—Required the content of a coiled spring made of $\frac{1}{4}$ inch square wire, the inner diameter of the spring being 2 inches, the pitch of the coil being $\frac{5}{16}$ inch, and the spring comprising 18 full turns.

The wire being square, its cross section made as required by the rule will not be a square, but a rectangle corresponding with the inclination of the coil. This rectangle can be easily determined.

In Fig. 23 let the line $n\ r$ represent the circumference of the helix. We find it to be in our example 6.2832 inches. Also let $r\ s$ = the pitch of the coil, in the present case $\frac{5}{16}$ inch. Also let $m\ o\ q\ s$ represent a section of the wire whose length = the circumference of the helix. Extend $m\ q$ to w and draw $w\ s$. Extend $s\ o$ also to n and draw $m\ n$. Then, as the triangles $n\ r\ s$, $q\ s\ w$, and $m\ n\ o$ are similar, if we let t = thickness of the wire, or line $m\ o$ in the figure, C = circumference of the helix or line $n\ r$ in the figure, and P = pitch or line $r\ s$, we may first express the length of the line $n\ s$ in terms of P and C, and then by a simple proportion determine the line $m\ n$ or its equal $w\ s$, which latter we will represent by v. Thus the line $n\ s$ is found to be

$$\sqrt{C^2 + P^2},$$

and

$$C : \sqrt{C^2 + P^2} :: t : v,$$

whence

$$v\ C = t \sqrt{C^2 + P^2}, \qquad (1)$$

$$\text{and } v = \frac{t \sqrt{C^2 + P^2}}{C}. \qquad (2)$$

In our case $t = \frac{1}{4}$ inch, $C = 2$ inches, and $P = \frac{5}{16}$ inch, whence

$$v = \frac{\frac{1}{4}\sqrt{4 + \frac{25}{256}}}{2}. \qquad (3)$$

Performing indicated operations, we get $v = 0.2518$; and this is the thickness of the coil measured on a plane coincident with the axis of the helix which the rule calls for. We can now write for area of cross-section:

$\frac{1}{4} \times 0.2518 = 0.06295$ square inch,

and by the rule:

$0.06295 \times (2\ 25 \times 3.1416) \times 18 = 8.00943$ cubic inches, the cubic content of the coil.

The area of cross section made as required by the rule in a helix of round wire would be an ellipse. In computing screw threads, to which we now return, this point need not be considered, because the required section is determined beforehand by the shape of the screw-cutting tool, and the special computation for area of cross section needed for the helix may be omitted.

We have thus approached a general rule for the computation of screw threads of any form whatever.

Rule XIII.—Consider each turn of the screw thread as the outer part of a symmetrical ring, whose outer and inner parts each have the same cross-section as that of the screw thread, and whose middle circle has the same diameter as the barrel of the screw. Find the content of such a ring by Rule XI. To half this content add half the difference between the outer and inner parts of the ring; the result will be the content of one turn of the thread, and this multiplied by the number of turns will give the entire content of the screw.

The computation of different formulas expressing the difference between the outer and inner parts of circular rings of different cross sections involves the use of the calculus. Without going over the entire ground, I will give rules for computing half-differences for the outer and inner parts of rings corresponding with screw threads met with in practice.

For a circular ring having a circular cross-section:

Rule XIV.—Multiply the difference between the outer and inner circumferences by the area of the cross section, and divide the product by 12.

For a circular ring having a rectangular cross section:

Rule XV.—Multiply the difference between outer and inner circumferences by the area, and divide the product by 8.

For a circular ring whose cross section is a rhombus. [Such a ring corresponds with a triangular screw thread, that is to say, such a thread is the outer part of a ring whose cross section is a rhombus.]

Rule XVI.—Multiply the difference between the inner and outer circumferences by the area of the cross section, and divide the product by 12.

For a ring whose cross section is a hexagon:

Rule XVII.—Multiply the difference between the outer and inner circumferences by the area, and divide the product by 8.

Example.—Required the total content of a V-shaped screw thread, on a screw whose barrel is 3 inches diameter, whose diameter over all is 4 inches, whose pitch is $\frac{1}{2}$ inch, and length is 3 feet, the bases of threads abutting.

The thread-section made on a plane co-

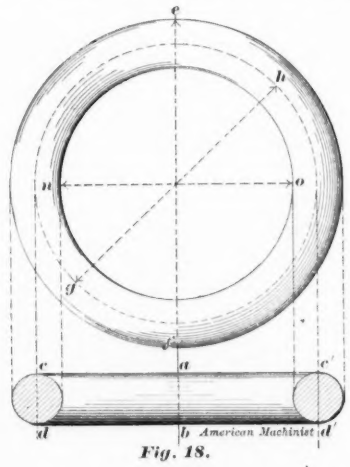


Fig. 18.

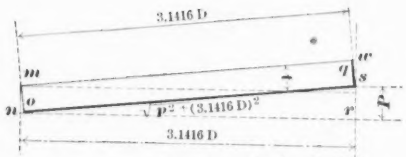


Fig. 23

incident with the axis of the screw, is half of a rhombus whose sides are each $\frac{1}{2}$ inch in length. The area of the section is easily found to be 0.2165 by the common rule for computing an area of this kind.

The circumference of the barrel is $3 \times 3.1416 = 9.4248$ inches, and $9\ 4248 \times 0\ 2165 = 2.04047$ cubic inches, which is the content of a ring having the rhombic cross-section, and whose middle circle has the same diameter as that of the barrel of the screw. A single turn of the screw thread is equal to the outer part of this ring, and this outer part is found by Rule XVI.

The inner diameter of the ring is 2 minus twice the depth of the thread, and the diameter over all is 3 plus twice this depth. The depth of the thread $= \sqrt{\frac{1}{2}''^2 - \frac{1}{4}''^2} = \frac{1}{4}\sqrt{3} = 0.433''$. Whence 2.134 inches is the inner diameter, and 3 866 inches is the diameter over all. The difference between inner and outer circumferences is equal to the difference of these diameters multiplied by 3.1416, and the half difference between the inner and outer parts may be expressed in cubic inches thus:

$$\frac{1\ 732 \times 3\ 1416 \times 2.165}{12} = 0\ 98169.$$

Half the content of the ring is 1 02 and this + 0.98169 gives the content of one turn of the thread = 2.00169 cubic inches, say 2 cubic inches. As the threads abut, and the pitch is $\frac{1}{2}$ inch, there are 72 turns of the thread in the screw, and the content of the entire thread is $72 \times 2 = 144$ cubic inches.

Rule XVIII.—To find the content of the interspace between the turns of a screw thread. Consider each turn of the interspace to be the inner part of a symmetrical ring, whose inner and outer parts have the same cross-section as that of the interspace, and whose middle circle has a diameter equal to that of the screw over all. Find the content of such a ring by Rule XI. From half of this content subtract half the difference between the inner and outer parts of the ring, the result will be the content of a single turn of the interspace, which multiplied by the number of turns will give the entire content.

With the exception that a subtraction is substituted for an addition, this rule and operations under it are the same as those just given. Further examples for this and other forms of threads are not necessary, as those who wish more practice can easily frame such examples.

A little ingenuity will enable these rules to be applied to screw threads like those illustrated in Figs. 17 and 20 in my last article, issue of June 21st. If for the form shown in Fig. 20, we make the diagram, Fig. 24, letting the line $A\ B$ represent the axis of a screw having $1\frac{3}{4}$ inches radius from this axis to outside of thread, and $1\frac{1}{4}$ inches radius from the axis to the base of the thread, it with be seen that the diameter of the barrel is $3\frac{1}{2}$ inches, and the pitch is 1 inch. Also it will be seen that the part $g\ h\ l$ of the section is the section of the outer half of a circular ring having a cir-

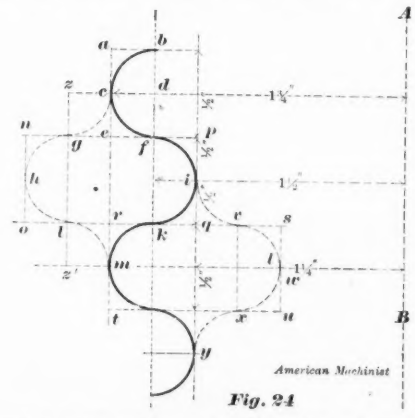


Fig. 24

cular cross section, the diameter of cross-section of such ring being $\frac{1}{2}$ inch, and the mean diameter of this ring being 4 inches. The part of the section $a\ g\ l\ m\ r\ e$ is less than that of a ring of rectangular cross-section $c\ z\ z'\ m$, the difference being the sum of the sectional parts $c\ z\ g$ and $l\ z'\ m$; but this sum = the sectional part $g\ h\ l$; whence the part $c\ q\ l\ m\ r\ e$ = the sectional part $c\ z\ z'\ m$ minus the sectional part $c\ f\ i\ k\ m\ r\ e$.

The computation is rather tedious unless logarithms be used.

Steam Production.

By W. H. Booth.

One occasionally comes across some very curious ideas in connection with steam raising and firing, and it is difficult to understand how men can justify them. Recently, in a discussion on steam raising, it was stated by one speaker that the use of a feed heater in the flues, such as is generally looked upon as an extension of the heating surface of the boiler, and to absorb some of the waste heat that would otherwise go to the chimney; or as simply to cover the errors of the fireman and absorb heat that the fireman had manufactured of a variety not capable of absorption by the boiler. The only possible way of understanding the drift of his words was to suppose that in some way or other the fireman could fire badly and produce heat that would not affect the boiler, but could be soaked out of the feed heater.

Now, a fireman can only make one mistake as regards his work in firing, and this one mistake is to turn the furnace products over the bridge at a lower temperature than he should do, and he can only do this, as a rule, by admitting air badly in large volumes and needlessly reducing the temperature of the products of combustion passing over the bridge. It is obvious, however, that a fireman's mistakes once made are made finally; there is no correcting them. Every unit of heat that might be got out of the coal, but is not, is gone forever, and every degree of temperature lost by dilution of cold air, is lost forever and cannot be absorbed by the boiler surface. Now, a feed heater cannot absorb heat that has not been produced, and is also less capable of absorbing heat when the difference of temperature between the boiler surfaces and the gases is reduced by cold air dilution. Further, when the reduced temperature is an effect of dilution the rapidity of movement of the gases past the feed heater is increased and less time is given for absorption.

If we take it that the temperature of a high pressure boiler is to day 350 degrees it follows that no boiler of reasonable size can reduce its furnace products to this temperature, for a long time would be required to equalize the temperatures, and yet 350 degrees is by no means too low a chimney heat. With the flue feed heater, however, there is introduced a large surface of comparatively cold metal to absorb the heat, and this represents the compound system in steam raising. It is very little good adding largely to boiler surface, because it is not difficult to reduce the gases to 600 degrees or 700 degrees in the boiler, and for further reduction a colder surface is then equally effective in reducing to a lower point.

Usually at present we employ a chimney to produce draught—a chimney is simply a kind of heat engine and works with flue gases at a temperature of about 350 degrees to 450 degrees. In a boiler of 1,000 horse power the chimney has a horse-power of about 170, this being about the proportion of temperature employed to operate it, of the whole furnace temperature. By reducing the waste gases to a still lower temperature we could save 80 or 100 horse-power, and a fan to aid the cooler chimney would not absorb anything like the power saved, all which would go to show that a still further extension of the principle of graduation could be effected by using a primary feed heater to attack the cooler gases after they have done duty upon one feed heater. But quite apart from the question of utilizing heat by reducing furnace gases to a minimum there comes in the practical consideration of what the minimum should be. Here feed heaters, it is well known, suffer from very severe corrosion of the lower ends of the water pipes. About a sixth of the lengths of the pipes rapidly decays, because, when fed with water at ordinary temperature, the steam gas produced in the furnace by the combustion of the hydrogens of the fuel becomes condensed on the cold pipes and absorbs the sulphur acids from the smoke. A valuable feed heater ought not to be fed with cold water, and with a fan draught an additional heater might be used to take the corrosion damages and save the larger and more costly heater.

But, with the high pressures of to-day, the feed pumps should not be allowed to force water through the first heater, because this would be liable to be weak from corrosion. A separate pump should be used for this. Unless therefore some suitable non corrosive material were forthcoming for the colder pipes in a flue feed heater there is a practical minimum of temperature for these articles, and indeed as much of the products of a furnace have a specific gravity greater than air, it is proper that they should not be rejected at too low a temperature, whereby they might fall to earth within too small a distance of the chimney, before they had been sufficiently dispersed in space to render them comparatively inoffensive. There are thus two limiting factors to temperature reduction, but the reduction of temperature that should be possible is quite large enough to call for the use of mechanically induced draught. As a general thing, it may be safely said that the two important factors in fuel economy are the reduction of the temperature of the waste gas to a reasonably low point at one end of the operation of combustion and their main-

tenance at a high temperature at the other end, which latter consideration, of course, involves the suppression as far as possible of the large excess of air so usually admitted over and above that chemically necessary for combustion. In fact, it is to useless air admission that we owe the greatest losses of efficiency for heating surfaces, in themselves of ample area to abstract heat from gases at 2,500 degrees, and reduce them to 700 degrees, would be quite incapable of abstracting the same amount of heat from gases at only 1,300 degrees, even though the weight of the gas were doubled for the energy of transmission, although the plates of the boiler would be less, as the *head* of temperature was less. A little thought expended on this idea would prevent any one thinking that a flue feed heater could soak out from waste gases the heat left in them as a result of the mistakes of the fireman. A fireman can only make one mistake, viz., to cause reduction of furnace temperature by improper air admission, so that it is manifestly absurd to suppose that such an error could be corrected by a feed heater, for a fireman's mistakes affect the heater equally with the boiler, and it is *because* a fireman cannot regain what he has once let slip that his work ought to be rated higher than it is. In many occupations a false move can be retrieved; it may cost time and trouble to retrieve a false move, but a fireman cannot do this. He is like the signalman on a railroad, once he has let the train past the block it is too late to retrieve. If this were better understood by the steam users there would be in general a better recognition of the position and duties of the boiler room.

I find this recognition among men who have a really practical knowledge of boiler-house conditions, but it is singularly lacking in large numbers of men who ought to know better, and I have heard it said that any man can fire a boiler.

A Belgian Fifteen-ton Electric Crane.

We present herewith engravings made from working drawings of a fifteen ton electric crane recently built and put in service at the shops of H. Bollinckx, Brussels, Belgium.

The crane has three motors, one for each motion, and these can be run at speeds varying from 0 to 1,200 revolutions, and can be reversed by the current without injury, so that brakes and clutches are not needed. Worm-gearing is used in the hoisting motion, and the load is thus sustained at any point. There are two ratios of speed between the hoisting motor and the load, the shaft H being shifted endwise to engage the gears at either side, as shown in the end view of crane.

In relation to the crane, Mr. Bollinckx writes: Unable to find anything in the market which seemed to meet all the practical points we desired to obtain, and we, therefore, designed this crane for our use. The following are the points we sought to attain:

Use of Continuous Currents.—(Because *a*). Owing to the regularity of our steam engine we could produce light and transmit power with one dynamo only, our dynamo for light purposes becoming a spare one.

(Because *b*). We can vary the speed of our electric driving motors with the greatest ease (this point being especially important in our foundry, when closing a mold).

(Because *c*). We can stop and reverse the rotation of the motor without having to take any care, the current can even be reversed before the motor is stopped, and this dispensed with the use of brakes.

(Because *d*). The collectors, owing to the use of coal brushes, do not wear out, hence, require no keeping in repair, as seven months' experience has proved to us.

The use of an electric driving motor for each motion, which considerably simplifies the mechanical part, there being no couplings required, the motors moving indifferently either way.

Current taken on wires by means of a rubber lined with soft metal, easily renewed.

The rubbers placed underneath the wires so that the wires can be laid upon insulated bearers above which the rubbers are passing.

This disposition was wanted in order to avoid an excessive tension of the leaders, the haul being 70 meters in length.

Besides, this disposition is more simple than trolleys, the conductors requiring no soldered ties to support them, they are merely laid upon the bearers, and the rubber lifts the same up when passing.

The commutators were required to have only one lever to excite the machine and to throw the current in the brushes.

The rightward motion giving direct rotation; leftward, giving reverse rotation. Thus, the man driving the crane has only three levers to work.

Use of endless screws to lift loads, dispensing with use of brakes, and keeping the load in suspension.

Use of friction balls for the thrusts of the endless screws, the whole being encased in a box filled with oil, so as to obtain the maximum power of use.

PERSPECTIVE DRAWING OF THE TRAVELING CRANE.

As will be observed, the driving motor B commands, by means of an endless screw and two conical worm-wheels, the shaft which moves the wheels of the traveling crane (by means of pinions and gears) to obtain the longitudinal motion.

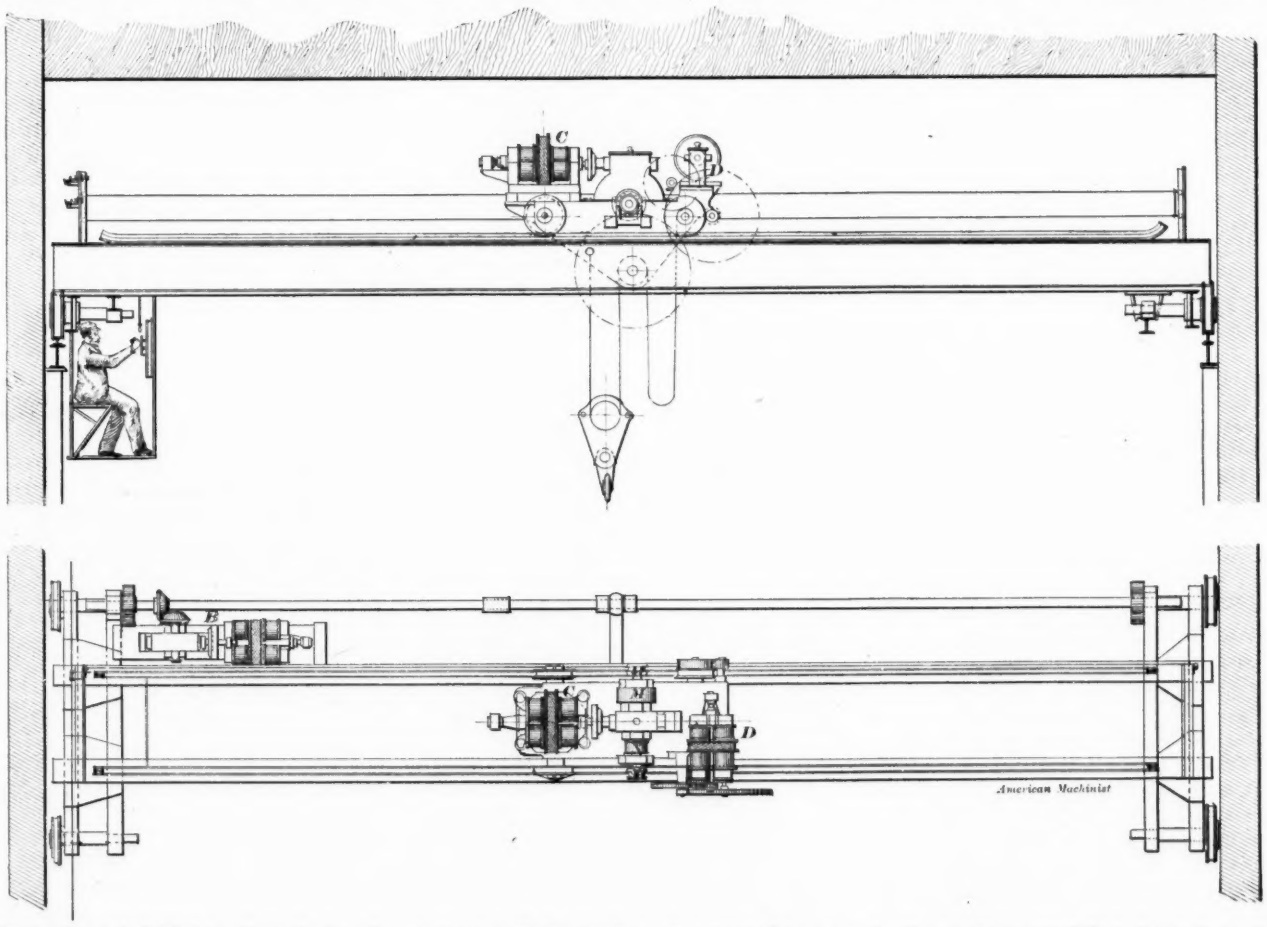
Motor C, placed on the trolley, commands, by means of an endless screw and gears, the wheel with gall chain.

Driving motor D, also placed on the trolley, moves it transversely.

This motor, in order to give the least possible length to the trolley, and so serve the greatest width of shop possible, moves the wheels by means of pinions and gears.

The pinion on the dynamo is of rawhide or compressed leather, in order to reduce the noise to a minimum.

The speed of the crane is 20 meters [65 feet 6 inches] in the longitudinal direction, and 9 meters [29 feet 6 inches] transverse. The lift is 3 meters [9 feet 10 inches] up to 8 000 kilos (8 tons), and 1 meter 50 centimeters [4 feet 11 inches] up to 15,000 kilos (15 tons) at variable speed between these weights from 0, the motors revolving from 0 to 1,200 revolutions, as desired, and are simply governed by the commutators, which possess resistances.



Different men come at things in different ways. It is reported of the illiterate country storekeeper who designated the sale of a cheese on credit by a circular sketch, and a grindstone by a similar sketch, with a square hole represented at the center, that he got pay for the articles just the same. We once, for some years, were on terms of intimacy with an engineer who was more than ordinarily noted for what he knew and what he produced, and the use he made, in arriving at conclusions, of inconsequential little machine products lying about loose on benches and around machines, while it mystified the beholder, seemed to guide him aright. It was his way of figuring, and it worked well.

It is satisfactory to know, as is being learned by repeated trials, that the Harvey process of treating steel plates for armor is all right when properly applied; that the trouble when it has come, has come through improper treatment, or through the attempt to treat defective plates. The Harvey process is not responsible for previous scamping of the work.

Comparison of Different Formulæ for Dimensions of Parts of Steam Engines.—II.

By William Kent, M. E.

Diameter of Piston Rods—Unwin gives

$$d' = b\,D\,\sqrt{p}, \qquad (1)$$

in which D is the cylinder diameter in inches, p is the maximum unbalanced pressure in pounds per square inch, and the constant $b = 0.0167$ for iron, and $b = 0.0144$ for steel. Thurston, from an examination of a considerable number of rods in use gives

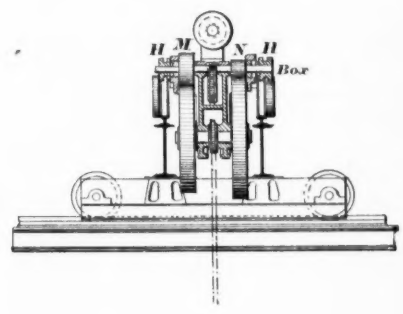
$$d' = \sqrt[4]{\frac{D^2\ p\ L^2}{a}} + \frac{D}{80}, \text{ nearly} \qquad (2)$$

(L in feet, D and d in inches,)

in which the constant $a = 10{,}000$ and upward in the various types of engines, the marine direct-acting screw engine or ordinary fast engines on shore giving the lowest values, while "low speed engines" being less liable to accident from shock give $a = 15{,}000$, often.

Connections of the piston rod to the piston and to the crosshead should have a factor of safety of at least 8 or 10.

Marks gives the following:



$$d' = 0.0179\,D\,\sqrt{p}, \qquad (3)$$

and $$d' = 0.03901\,\sqrt[4]{D^2\,l^2\,p}, \qquad (4)$$

in which l is the length of stroke, all dimensions in inches. Deduce the diameter of piston rod by (3), and then if this diameter is less than $\frac{1}{12}l$, then use (4). These are for wrought-iron; for steel he gives

$$d' = 0.0105\,D\,\sqrt{p}, \qquad (5)$$

and $$d' = 0.03525\,\sqrt[4]{D^2\,l^2\,p}, \qquad (6)$$

the latter to be used if the result of (5) is less than $\frac{1}{8}l$.

Seaton gives the following as sufficiently accurate for all practical purposes:

Diameter of piston rod $=$

$$\frac{\text{Diameter of Cylinder}}{F}\sqrt{p}.$$

The following are the values of F:

Naval engines, direct acting, $F = 60$.

Naval engines, return connecting-rod, 2 rods, $F = 80$.

Mercantile ordinary stroke, direct-acting, $F = 50$.

Mercantile long stroke, direct acting, $F = 48$.

Mercantile very long stroke, direct-acting, $F = 45$.

Mercantile medium stroke, oscillating, $F = 45$.

NOTE.—*Long and very long*, as compared with the stroke usual for the power of engine or size of cylinder.

In considering an expansive engine p, the effective pressure, should be taken as the *absolute* working pressure, or 15 pounds above that to which the boiler safety valve is loaded; for a compound engine the value of p for the high pressure piston should be taken as the absolute pressure, less 15 pounds, or the same as the load on the safety valve; for the medium pressure the load may be taken as that due to half the absolute boiler pressure; and for the low-pressure cylinder the pressure to which the escape valve is loaded + 15 pounds, or the maximum absolute pressure, which can be got in the receiver, or about 25 pounds. For several obvious reasons it is an advantage to

make all the rods of a compound engine alike, and this is now the rule.

Applying the above formulæ to our engines of 10, 30 and 50 in. diameter, both short and long stroke, we have:

DIAMETER OF PISTON RODS.

Diameter of Cylinder—Inches. Stroke—Inches.	10			30			50		
	12		24	30		60	48		96
Unwin, iron, .0167 $D\sqrt{p}$	....	1.67	....	....	5.01	....	....	8.35	....
Unwin, steel, .0144 $D\sqrt{p}$	....	1.44	....	....	4.32	....	....	7.20	....
Thurston, $\sqrt{\frac{D^2 p L^2}{10{,}000} + \frac{D}{80}}$, ($L$ in feet.)	1.13	....	....	3.12	....	....	5.10	....	....
Thurston, same with $a = 15{,}000$	....	....	1.40	....	....	3.88	....	....	6.35
Marks, iron, .0179 $D\sqrt[4]{p}$	1.79	....	....	5.37	....	5.37	8.95	....	8.95
Marks, iron, .03901 $\sqrt[4]{D^2 l^2 p}$	1.35	....	1.91	3.70	....	5.13	6.04	....	8.54
Marks, steel, .0105 $D\sqrt[4]{p}$	(1.05)	....	....	(3.15)	....	....	(5.25)	....	....
Marks, steel, .03525 $\sqrt[4]{D^2 l^2 p}$	1.22	....	1.73	3.34	....	4.72	5.46	....	7.72
Seaton, naval engines $\frac{D}{60}\sqrt{p}$	1.67	....	....	5.01	....	....	8.35	....	....
Seaton, land engine, very long stroke $\frac{D}{45}\sqrt{p}$	....	....	2.22	....	....	6.67	....	....	11.11
Average of four, for iron	1.49	....	1.82	4.80	....	5.26	7.11	....	8.74

An empirical formula which gives results approximating the above averages is $d'' = .013\sqrt{D l p}$.

The calculated results from this formula for the six engines are respectively:

1.42; 1.88; 3.90; 5.61; 6.37; 9.01.

The figures in brackets opposite Marks third formula would be rejected since they are less than $\frac{1}{8}$ of the stroke, and the figures derived by his fourth formula would be taken instead. The figures 1.79 opposite his first formula would be rejected for the engine of 24 inch stroke.

Piston Rod Guides.—The thrust on the guide, when the connecting rod is at its maximum angle with the line of the piston rod is found from the formula,

Thrust = total load on piston × tangent of maximum angle of connecting rod = p tan Θ.

This angle is the angle whose tangent = $\frac{\text{half stroke of piston}}{\text{length of connecting rod}}$

Ratio of length of connecting rod to stroke	2	2½	3
Maximum angle of connecting rod with line of piston rod	14° 29′	11° 19′	9° 36′
Tangent of the angle	.25	.20	.1667
Secant of the angle	1.0308	1.0198	1.0138

Seaton says: The area of the guide block or slipper surface on which the thrust is taken, should in no case be less than will admit of a pressure of 400 pounds on the square inch; and for good working those surfaces which take the thrust when going *ahead* should be sufficiently large to prevent the maximum pressure exceeding 100 pounds per square inch. When the surfaces are kept well lubricated this allowance may be exceeded.

Thurston says: The rubbing surfaces of guides are so proportioned in what is generally considered good practice that if V be their relative velocity in feet per minute, and p be the intensity of pressure in pounds per square inch, $p\ V < 60{,}000$ and $p\ V > 40{,}000$.

The lower is, of course, the safer limit; but for marine and stationary engines it is allowable to take $p = \frac{60{,}000}{V}$. Professor Thurston has found this a successful proportion in his own experience and practice; or, according to Rankine, for locomotives, $p = \frac{44{,}800}{V + 20}$, where p is the pressure in pounds per square inch, and V the velocity of rubbing in feet per minute. This includes the sum of all pressures forcing the two rubbing surfaces together.

Some British builders of portable engines restrict the pressure between the guides and crossheads to less than 40, sometimes 35 pounds per square inch.

For a mean velocity of 600 feet per minute, Professor Thurston's formulas give, $p < 100$, $p > 66.7$; Rankine's gives $p = 72.2$ pounds per square inch.

Whitham gives, A = area of slides in square inches $= \frac{P}{p_0\sqrt{n^2 - 1}} = \frac{.7854\ d^2\ p_1}{p_0\sqrt{n^2 - 1}}$, in which P = total unbalanced pressure, and p_1 pressure per square inch on piston, d = diameter of cylinder, p_0 pressure allowable per square inch on slides, and n = length of connecting rod ÷ length of crank. This is equivalent to the formula, $A = P$ tan. Θ ÷ p_0. For $n = 5$, $p_1 = 100$ and $p_0 = 80$, $A = .2004\ d^2$. For the three engines 10, 30 and 50 inches diameter, this would give for area of slides, A = 20, 180 and 500 square inches, respectively. Whitham says: The normal pressure on the slide may be as high as 500 pounds per square inch; but this is when there is good lubrication and freedom from dust. Stationary and marine engines are usually designed to carry 100 pounds per square inch, and the area in this case is reduced from 50 to 60 per cent. by grooves. In locomotive engines the pressure ranges from 40 to 50 pounds per square inch of slide, on account of the inaccessibility of the slide, dirt, cinder, etc.

There is perfect agreement among the authorities as to the formula for area of the slides, $A = P$ tan. Θ ÷ p_0, but the value given to p_0, the allowable pressure per square inch, ranges all the way from 35 pounds to 500 pounds.

The Connecting Rod.—Ratio of length of connecting rod to length of stroke.

Experience has led generally to the ratio of 2 or 2½ to 1, the latter giving a long and easy-working rod, the former a rather short, but yet a manageable one (Thurston.) Whitham gives the ratio of from 2 to 4½, and Marks from 2 to 4.

Dimensions of the Connecting Rod.—The calculation of the diameter of a connecting rod on a theoretical basis, considering it as a strut subject to both compressive and bending stresses, and also to stress due to its inertia, in high-speed engines, is quite complicated. See Whitham, Steam Engine Design, p 217; Thurston, Manual of S. E., p 100. Empirical formulas are as follows: For circular rods, largest at the middle, D = diameter of cylinder, l = length of connecting rod in inches, p = maximum steam pressure per square inch.

(1) Whitham, diameter at middle, $d'' = 0.0272\sqrt{D l \sqrt{p}}$.

(2) Whitham, diameter at necks, $d'' = 1.0$ to $1.1 \times$ diameter of piston rod.

(3) Sennett, diameter at middle, $d'' = \frac{D}{55}\sqrt{p}$.

(4) Sennett, diameter at necks, $d'' = \frac{D}{60}\sqrt{p}$.

(5) Marks, diameter, $d'' = 0.0179\ D\sqrt{p}$ if diameter is greater than $\frac{1}{24}$ length.

(6) Marks, diameter, $d'' = 0.02758\sqrt{D l \sqrt{p}}$ if diameter found by (5) is less than $\frac{1}{24}$ length.

(7) Thurston, diameter at middle, $d'' = a\sqrt{D L \sqrt{p}} + C$, D in inches, L in feet. $a = 0.15$, and C ¼ inch for fast engines; $a = 0.08$, and $C = \frac{3}{4}$ inch for moderate speed.

(8) Seaton says: The rod may be considered as a strut, free at both ends, and calculating its diameter accordingly. Diameter at middle $\frac{\sqrt{R\,(1 + 4\,a\,r^2)}}{48.5}$,

R = the load on piston, P, multiplied by the secant of the maximum angle of obliquity of the connecting rod.

For wrought iron and mild steel a is taken at $\frac{1}{3000}$.

The following are the values of r in practice:

Naval engines—direct-acting, $r = 9$ to 11.

Naval engines, return connecting rod $r = 10$ to 13, old.

Naval engines, return connecting rod $r = 8$ to 9, modern.

Naval engines, trunk, $r = 11.5$ to 13.

Mercantile engines, direct acting, ordinary $r = 12$.

Mercantile engines, direct-acting long stroke $r = 13$ to 16.

(9) The following empirical formula is given by Seaton as agreeing closely with good modern practice:

Diameter of connecting rod at middle $= \frac{\sqrt{l\,K}}{4}$,

l = length of rod in inches, and K = 0.03 × effective load on piston in pounds.

The diameter of the connecting rods at the ends may be 0.875 of the diameter at the middle.

Seaton's empirical formula when translated into terms of D and p is the same as the second one by Marks, viz., $d'' = 0.02758\sqrt{D l \sqrt{p}}$. Whitham's (1) is also practically the same.

(10) Taking Seaton's more complex formula, with length of connecting rod = 2½ × length of stroke, and $r = 12$ and 16 respectively, it reduces to

Diameter at middle = $.02294\sqrt{P}$ and $.02411\sqrt{P}$

for short and long-stroke engines, respectively.

Applying the above formulæ to the engines of our list, we have,

DIAMETER OF CONNECTING RODS.

Diameter of Cylinder—Inches. Stroke—Inches.	10			30			50		
	12		24	30		60	48		96
Length of Connecting Rod M.	30		60	75		150	120		240
(3) $d'' = \frac{D}{55}\sqrt{p} = .0182\ D\sqrt{p}$	....	1.82	....	....	5.46	....	....	9.09	....
(5) $d'' = .0179\ D\sqrt{p}$	1.79	....	....	5.37	....	....	8.95	....	....
(6) $d'' = .02758\sqrt{D l \sqrt{p}}$	....	....	2.14	....	....	5.85	....	....	9.51
(7) $d'' = 0.15\sqrt{D L \sqrt{p} + ½}$	2.87	....	....	7.00	....	....	11.11	....	....
(7) $d'' = 0.08\sqrt{D L \sqrt{p} + ¾}$	....	....	2.54	....	....	5.65	....	....	8.75
(10) $d'' = .02294\sqrt{P}$; $.02411\sqrt{P}$	2.03	....	2.14	6.09	....	6.41	10.16	....	10.68
(9) $d'' = .08\sqrt{P}$	....	2.67	....	....	7.97	....	....	13.29	....

Tapered Connecting Rods.—In modern high speed engines it is customary to make the connecting rods of rectangular instead of circular section, the sides being parallel, and the depth increasing regularly from the crosshead end to the crank-pin end. According to Grashof, the bending action on the rod due to its inertia is greatest at $\frac{6}{10}$ the length from the crosshead end, and, according to this theory, that is the point at which the section should be greatest, although in practice the section is made greatest at the crank-pin end.

Professor Thurston furnishes the writer with the following rule for tapered connecting rod of rectangular section. Take the section as computed for a circular section and for a rod ¼ the actual length, placing the computed section at ⅝ the length from the small end, and carrying the taper straight through this fixed section to the large end. This brings the computed section at the surge point and makes it heavier than the rod for which tapered form is not required.

To develop this into a formula, let us take Thurston's formula for rods for high-speed engines $d = 0.15\sqrt{D L \sqrt{p}}$, (dropping the added ½ inch since comparing it with other formulæ it seems to be unnecessary). Multiplying L by ⅘, and changing it to l in inches, the formula becomes $d = 0.05\sqrt{D l \sqrt{p}}$. Taking a rectangular section equivalent to the round section whose diameter is d, making the depth of the section h = twice the thickness t, we have, $.7854\ d^2 = h\ t = 2\ t^2$, whence $t = .627\ d = .0313\sqrt{D l \sqrt{p}}$, which is the formula for the thickness or distance between the parallel sides of the rod. Making the depth at the crosshead end = 1.5 t, and at ⅓ the length 2 t, the equivalent depth at the crank end is 2.25 t. Applying the formula to the high-speed engines of our examples, we have

Diameter of Cyl.—Inches. Stroke—Inches.	10 12	30 30	50 48
Length of connecting rod.	30	75	120
Thickness .0313 $\sqrt{D l \sqrt{p}}$.	1.71	4.70	7.67
Depth at crank end = 2¼ t.	3.85	10.57	17.25
Depth at crosshead = 1⅓ t.	2.57	7.05	11.50

The Crank pin.—A crank-pin should be designed, (1) to avoid heating, (2) for strength, (3) for rigidity. The heating of a crank-pin depends on the pressure on its rubbing surface, and on the coefficient of friction, which latter varies greatly according to the effectiveness of the lubrication. It also depends upon the facility with which the heat produced may be carried away; thus it appears that locomotive crank-pins may be prevented to some degree from overheating by the cooling action of the air through which they pass at a high speed.

Marks gives,

$$l = .0000247\ f\ p\ N\ D^2 = 1.038\ f\ \frac{(I.\ H.\ P.)}{L} \qquad (1)$$

Whitham gives,

$$l = 0.9075\ f\ \frac{(I.\ H\ P.)}{L} \qquad (2)$$

in which l = length of crank-pin journal in inches, f = coefficient of friction, which may be taken at .03 to .05 for perfect lubrication, and .08 to .10 for imperfect; p = mean pressure in the cylinder in pounds per square inch; D = diameter of cylinder in inches; N = number of single strokes per minute; $I.\ H.\ P.$ = indicated horse power; L = length of stroke in feet. These formulæ are independent of the diameter of the pin, and Marks states as a general law, within reasonable limits as to pressure and speed of rubbing, the longer a bearing is made, for a given pressure and number of revolutions, the cooler it will work; and its diameter has no effect upon its heating. Both of the above formulæ are deduced empirically from dimensions of crank-pins of marine engines. Whitham's ("Steam Engine Design," p. 230), is from the data of 10 crank pins of engines in British war ships.

The length and diameter of the pins, respectively, are 13″x13″, 14″x20″ and 17.5″x17.5″. The velocity of rubbing surface of pins ranges from 306 to 356 feet per minute; the work of friction per square inch of projected area of pin, the coefficient being taken at .05, ranges from 4,060 to 9,578 foot-pounds per minute, averaging 5,086.6, and the pressure per square inch of projected area (= length × diameter) ranges from 224 to 538 pounds, averaging 365.4 pounds. Marks' is taken from the crank-pins of four U. S. war vessels. The lengths and diameters are, respectively, 12″x8.5″, 9″x7.5″, 27″x16″ and 16″x15″, the velocity of rubbing surface ranges from 130 to 196 feet per minute; the pressure per square inch of projected area from 419 to 727 pounds, and the work of friction per square inch of projected area from 3,700 to 4,662, averaging 4,159 foot-pounds per minute. Marks says that about one-fourth the length required for crank-pins of propeller engines will serve for the pins of side wheel engines, and one-tenth for locomotive engines, making the formula for locomotive crank-pins, $l = .00000247\ f\ p\ N\ D^3$, or if $p = 150$, $f = .06$, and $N = 600$, $l = .013\ D^3$.

Friction Roll Drop Hammer.

The accompanying illustrations show an improved drop hammer which is especially designed for forging operations.

The hammer has double pulleys and steel gears which are easily replaced. The hammer is raised by friction rolls acting upon a board attached to the hammer head. Below the rolls there are clamps that hold the hammer in its elevated position. Both rolls and clamps are adjustable for different thicknesses and wear of boards. The clamps allow the board to pass up freely, but clamp and hold it in the position to which it is raised by the rollers until the treadle is depressed. So long as the treadle is kept down the machine makes continuous blows; otherwise it makes a single blow and returns. The upper dog on the upright rod in front of the machine regulates the height to which the head is raised, and it can readily be adjusted for any required height. At the same time, either by the hand lever or by the treadle, the height and the force of the blow can be varied independently of the dog.

The automatic trip mechanism, which is shown enlarged in a separate view, is so arranged that it works with unusual quietness and freedom from jar. The head has an inclined surface *a* upon it, which, coming in contact with the arm or lever *b*, turns the short upright shaft *c*, to the lower end of which is attached the latch *d*, which, when thrown in by a spring, engages in a notch in the shaft *e*, holding it up.

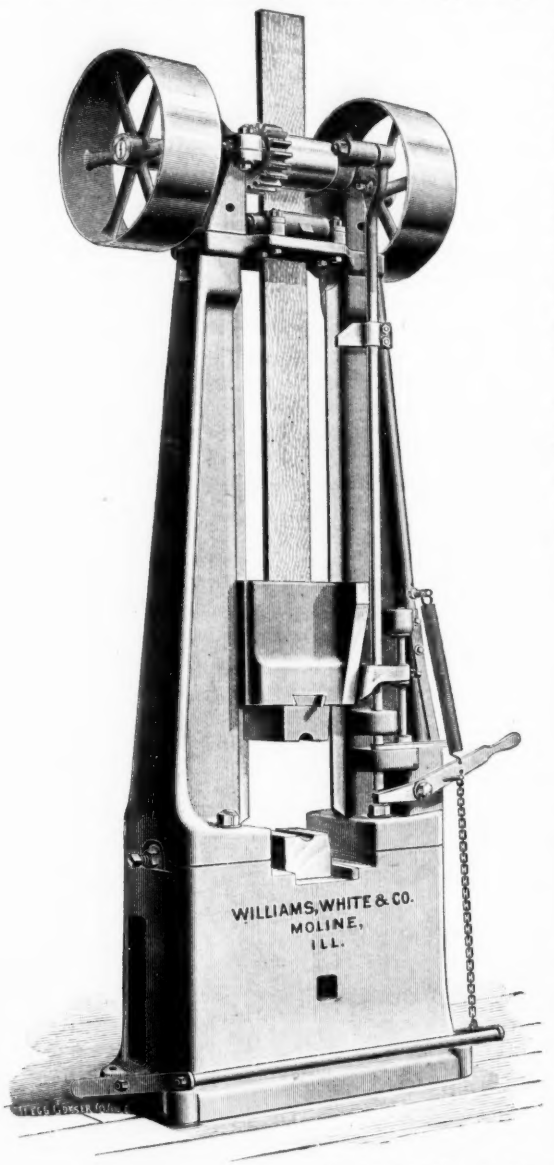
When the incline on the head strikes the arm *b*, it swings out on its shaft as a pivot, and the latch with the shaft, so that the latch is withdrawn from the notch, and the rod *e* is permitted to fall. This brings the rolls into contact with the board and raises it. As soon as the rod is raised again, either by the head striking on the upper dog, or by the hand lever and treadle, the latch is thrown back under the notch by a spring.

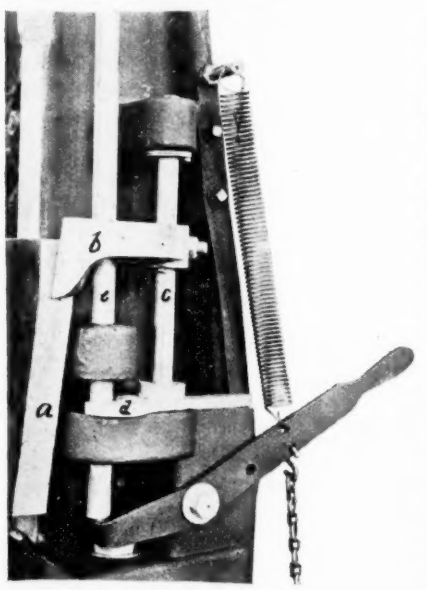
It will be seen that the arm *b* is adjustable vertically upon the shaft *c* to suit different thicknesses of dies.

Special pains are taken to provide against loosening of bolts, nuts, etc., by jarring, and, if desired, the guides and head are made of steel.

The hammers are made in eight sizes, with heads weighing from 200 pounds to 1,800 pounds, and with height of uprights from 60 inches to 108 inches; 11 inches to 16 inches between guides.

The machines are also made in somewhat modified form, adapting them to larger or sheet metal work. The manufacturers are Williams, White & Co., Moline, Ill.





Friction Roll Drop Hammer.

Improved Pillar Shaper.

We present herewith engravings showing an improved pillar shaper made by the Hendey Machine Co., Torrington, Conn.

Fig. 1 shows the machine complete, while Fig. 2 shows, enlarged, the sliding, leveled dog by which the stroke is adjusted while the machine is in motion. At first the idea of this adjustment was that, after setting the dogs for a given stroke, it could be adjusted closer for very exact work; but its value was soon demonstrated in allowing the stroke to be changed while in motion, especially when doing such die work as is indicated in Fig. 3, where, as the tool feeds along from one side to the other, the stroke is changed to suit the outline shown by

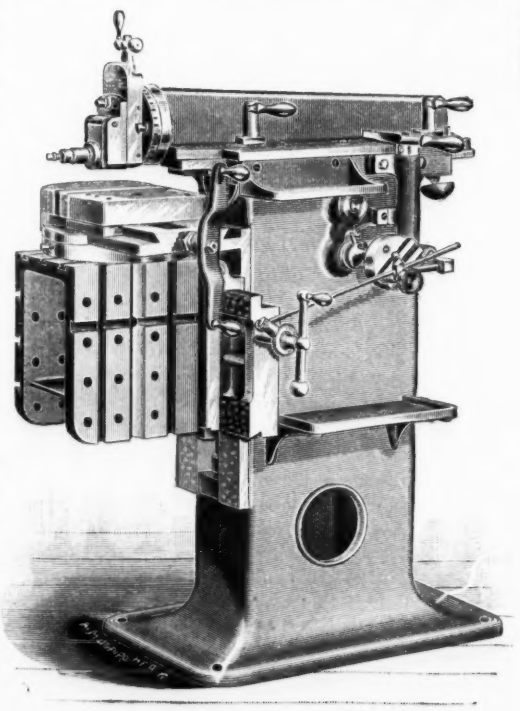


Fig. 1.

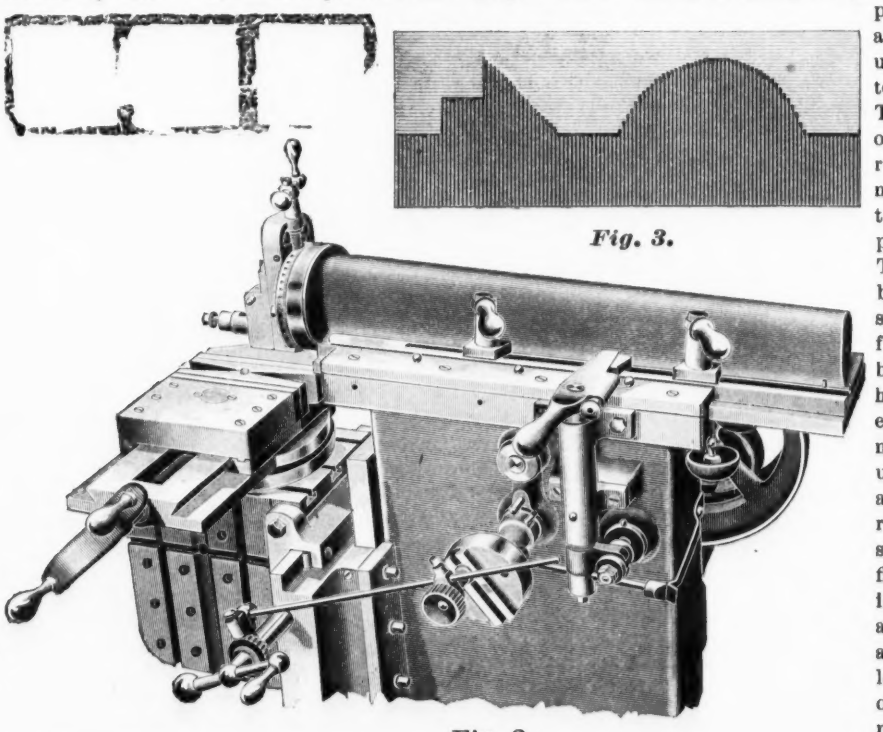


Fig. 2.

Improved Pillar Shaper.

Fig. 3.

simply moving a knurled disk upon the shifting lever, which moves the wedge seen at the right of the lever. This is found to be very convenient and to make an improvement of considerable importance.

Fig. 2 shows also a spring attached to the back of the column by which the friction clutch is held firmly in place after reversing. The old mechanism would sometimes allow the clutch to rebound and free itself, and it would also sometimes fail to reverse at slow speeds, both of which difficulties are entirely overcome by this improvement, the clutch being made much more certain in its action.

The new torpedo boat "Ericsson," recently launched from the yard of the Iowa Iron Works, Dubuque, Ia., is now preparing for her official trial.

Friction Wheels on Tools.

No one in the habit of observing developments in machine tool design can fail to be impressed with the increasing use of friction wheels for transmission of motion, especially in feed mechanisms.

A few years ago friction wheels were rare, about the only considerable use of them, extending back more than five years, being on the Sellers' lathes. Now they are used in various forms on lathes, drill presses, milling machines, boring mills, grinders, etc., mostly for feed motions, but occasionally for heavier service; both drill presses and lathes being shown at Chicago, driven by friction wheels.

The advantages of this method of driving are obvious; and the greatest of them, perhaps, is in the fact that changes of speed ratio are very readily made without stopping the motion, and that the ratio may be expressed by any number integral or fractional, within the total range; which range may also usually be greater than can be conveniently attained by other methods. Smoothness of action and entire absence of noise add also to its desirability.

The main objection to its employment has been its non-positive character, and, of course, where absolutely positive driving or ratios are required it cannot be used. But, where a small amount of slip or uncertainty of ratio is admissible, friction wheels are proving themselves well adapted to many purposes, especially when pains are taken to see to it that the required moment of force transmitted through them is secured by relatively high speed of the friction surfaces rather than by heavy pressure between them. This, it seems to us, is one of the principal points, if not the most important point to be observed in designing such wheels, for where the pressure between them must be heavy in order to make them drive, considerable width of surface is necessary to stand the pressure, and this increases the proportion of rubbing friction when the wheels are disks placed at right angles to each other, and, in any arrangement, increases the pressure and wear upon the journals. Narrow friction surfaces, running at relatively high speeds, and under light pressure seem to be necessary conditions to complete success, and when somewhat heavy pressures must be used, two opposing wheels so placed as to relieve the journals of excessive side strain, may make the difference between success and failure, even where one of these wheels is an idler. Thrust may usually be carried upon steel balls with advantage.

Effect of Heat on Tool Steel.

The discussion brought on by the presentation of Professor Bristol's paper at the Montreal meeting of the A. S. M. E. seemed to show that it is by no means as thoroughly understood as it might be, that it is much easier to bend or straighten a piece of steel when it is at a temperature of 200 degrees to 400 degrees than when cold, and that a piece of steel which will certainly break before taking the desired amount of permanent set when cold, may frequently be bent with very little danger of breaking when heated to a temperature considerably below that required to draw the temper.

Filemakers recognize this when they straighten files while still hot from the tempering bath; files which we all know cannot, when cold, be given the least permanent set without breaking.

Every toolmaker is familiar with the fact that a reamer, sprung in hardening so much that it will not true up in the grinder, can usually be readily straightened in the screw press if scoured, and then heated until it just begins to show color again. This is a common operation in tool rooms, and has made familiar to toolmakers the principle involved. The case mentioned by Mr. Geo. R Stetson, in which it was found that steel bars moderately heated broke more easily and with a more regular fracture, instead of being an opposite experience, as might be supposed, is a confirming one, showing that the moderate degree of heat applied simply allowed the molecules of the metal to move upon each other more easily, and, by relieving internal strains and reducing the internal structure more nearly to a normal condition, caused the fracture to take place more nearly upon the line called for by the stress imposed upon the bar. In other words, while the fracture of a cold steel bar by transverse stress is usually modified in form

by internal stresses existing in the bar, the application of a moderate degree of heat even as low as 212 degrees is sufficient in some cases to so far relieve these internal stresses as to make the fractures noticeably more regular in form.

It was evidently difficult for some of those who took part in the discussion to get rid of the idea that a change of temper (using the word temper in its ordinary sense) was thought by Mr. Almond to have taken place in the steel wire by passing it through a bath of boiling water; the vital point in his process being, however, that the wire is coiled while hot, and he did not claim that if allowed to cool again before being coiled it would coil easier or with less danger of breakage.

As a matter of fact, however, we doubt that there is a sharp dividing line between a heat which draws the temper of steel and one which does not. We are accustomed to regard 430° F. as about the lowest temperature which affects the temper of tool steel; but this notion probably arises from the circumstance that this is about the temperature at which temper color begins to show upon steel, and it is quite possible that temper is affected by temperatures considerably lower—even as low as 200° F., only we have no means of readily detecting the change.

LETTERS FROM PRACTICAL MEN.

Piecework.

Editor American Machinist:

I think it takes a more honest man to work piecework than it does to work day work. It has been my experience in looking over work that has been done by some dishonest pieceworker, to find holes drilled out of line. Take a compound rest for a large lathe, for instance. I have seen holes drilled out $\frac{1}{16}$ of an inch, and the workmen tried to put pieces together in that condition. They succeeded to a certain extent, and passed the lathe from their hands as complete. Taking a shop phrase, "You could stand half way across the shop and throw the screw into place." The workmen are sharp enough to leave the outside holes good, but oh! how the threaded holes do suffer to make them come into line. Lathe and planer hands are no better than the poor fellow who stands up to the bench and shoves the file or scraper for ten hours. I have found some very bad fits made by the lathe hands. They have called me to look at jobs that they knew were not right, and tried to shove them off onto the fitters to finish for them. Their complaint: "We are running behind on this job, and we must slight some of our work to come out even, or the secretary will not give us the pay." I am heartily in favor of piecework; I only want to show Mr. "Superintendent" that he will have to keep his eyes open or he will get bit by some of his men. There are a goodly number of working men who are strictly honest, and try to do good work, but sometimes the superintendent is hurried by some authority over him, and he comes to the men and tries to hurry them up; and the men get into the habit of saying, "Oh! that's good enough for this time," and sometimes the good enough don't pass inspection, and then is when the fun commences. The machine has arrived at its destination and the superintendent looks it over, and he runs across some of the "good enough" fits, and sends word back to the builder, and then is when the foreman gets his blessing. The great reduction Mr. "Superintendent" made in one certain operation will be apt to set a good many men to thinking, besides reducing his force 50 per cent. I know a man who had from 15 to 30 men working for him building large tools. He got a certain price for each size machine he made; he got good wages when the work came to him in good shape, and lots of it, but when planer and lathe castings were coming out slow, he had some tall hustling to keep his men going, and made complaint to the superintendent and foreman and wanted his force reduced, and the reply he would get—"Set them on the bench, and when you want a man take him down." This was not very pleasant for the pieceworkers, but when he could get his work in shape, he would drive his men to their utmost to make up for lost time, but he did it in a pleasant way, and his men would do all they could for him. This same man came behind on his piecework prices, and the company stopped his pay, but it was no fault of his. They raised the men's pay, but forgot to place any more money on the machines.

There was some trouble in the office when his pay was stopped. They thought he could live on what he had made the year previous.

I believe it pays a firm when they have good honest workmen to hold on to them and not treat them as one of their machines. There is one thing that piecework does, *i. e.*, it puts men to thinking how to reduce the cost of getting out work, and they fix up their little rigs, and hide them away for their own use. Sometimes they go to the superintendent for them, and he gets the glory for what his men have done.

In regard to drill-press feeds. I saw a manager going through his shop one day; he passed a drill press, and the operator had the feed on and was doing about all the press would do. The operator was having it too easy, so he ordered him to feed by hand, saying to him, "he would have all the cursed feeds taken off his presses as it had a tendency to make men lazy." It does hurt some managers if they see their men having a little easy time. They like to see their men sweltering in sweat, and with half their clothes torn off. "Pieceworker."

Milling Machine Practice.

Editor American Machinist:

I read with great interest Mr. Arnold's last article on "Milling." I have two of Brown & Sharpe's Lipe machines in constant work, and can bear out every claim made for their excellence and for the powerful cuts which they can take

I was also pleased to see that Mr. Arnold praised the cutters with the herring bone tooth line, the performance of which have been somewhat of a surprise to him. I am sure that had Mr. Arnold known the name of the inventor he would have mentioned it. The patentee is Mr. Alfred Muir, of the firm of William Muir & Co., Limited, Manchester, England, who have been manufacturing these cutters in large quantities during the last 13 years, both for the home and American market, where it is patented.

I have several times seen tests made in Muir's shops upon new vertical cutting machines, fitted with this class of cutter, operating upon marine cranks, which greatly astonished me, though an old hand at milling. I have no doubt that were you to communicate with Mr. Muir, he would be glad to give you some data of their performances, which, to know, would be an acquisition to the engineering trade in general. Hans Renold.

Copying Machine Design.

Editor American Machinist:

There have appeared from time to time in your paper several articles on the above subject, some of them being to the effect that the copyist generally left out the very essence of the design he was appropriating. There is an instance of this in the shop of a friend of mine—an emery grinder, made by quite a well known firm. Nearly all your readers are more or less familiar with the device to prevent the oil from flying by centrifugal force on high-speed machinery, namely, a small groove turned near the end of the hub that comes next to the box or bearing, the box being cupped out on the end, so as to partly cover the groove as shown in Fig. 2. The smart Aleck in question probably sought to shield himself from the charge of mechanical piracy, so he changed the design a little, putting the groove on the box and cupping out the end of the hub that ran next to it, as shown in Fig. 1, thus defeating the very object of the groove, as my friend can testify. To be effective, the groove should, of course, be on the revolving, not the stationary part.

Walter Gribben.

Belting Machine Tools.

Editor American Machinist:

I noticed a short time ago in one of the mechanical papers, a design for a lathe and in another a design for a milling machine,

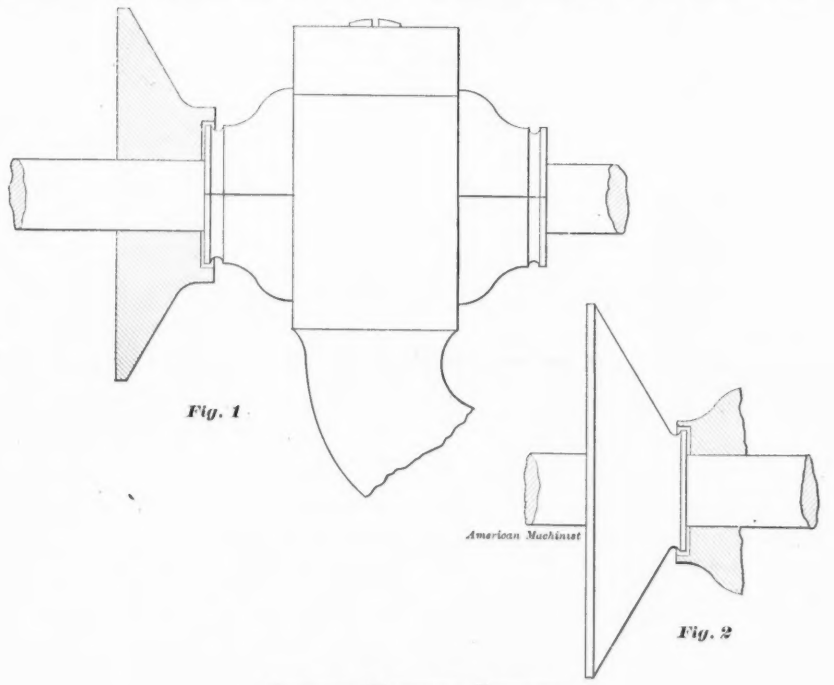


Fig. 1 Fig. 2

Copying Machine Designs.

with the countershaft underneath and having a belt on each step of the driving cone. In the shop where I am employed, we have a lathe with the countershaft underneath, and it has always been to me a regular nuisance.

In screwing a chuck on or off the spindle, it has to be turned a part of a revolution at a time. If we had a belt we could get a hold of, we could put the chuck on or off in half the time. It causes the same delay in truing up work in the chuck. The lathe has to be started and stopped to see how the piece runs.

As this is a high speed lathe, it takes considerable time. The borings and dirt work their way down onto the belt and countershaft, and the belt from main shaft to countershaft has to be boxed up to keep things from being caught in it. The lathe or milling machine has to be located either directly above or below the main shaft to avoid taking up too much space with the driving belt and its guard. The head stock or column has to be slotted to let the belt through, which weakens it in a very important part. In a milling machine of the ordinary type, without back gear, there is nothing to hold to to keep the spindle from turning when the arbor nut is loosened or tightened but the belt.

If this is put underneath it makes it very inconvenient to loosen or tighten the nut.

The only thing I can see in favor of the new design is the rapid changing of speed, and even this is not so important in milling machine construction.

The thing to be changed rapidly is the feed, as on the same job with the same cutter the feed can be varied to great advantage for roughing and finishing cuts.

I would be glad to hear some other opinions on this subject. E. M. C.

Measuring vs. Guessing.

Editor American Machinist:

There seems to be two methods of working among machinists of nearly all jobbing shops—one is the practice of *measuring* everything, no matter how rough or off-hand the job may be, never depending on the eye or judgment for anything; while the other is the "near enough" or guesswork method. Now, unlike some, perhaps, I can see good features in both these methods, especially the latter. I know the mechanical world is pre-eminently a world of exactness; in it things must be "about so," as the saying is, or they will not work. However, I think it is with this as with nearly everything else, it is subject to great modifications. I know I have seen machinery running year after year which was not by any means "about so," and yet it did good service for its owners, and practically answered the purpose just as well as though it had been the most finely adjusted and elaborately finished in the world. I have seen old engines—scrap heaps rather—running in laundries and other places, whose vitality and capacity for work seemed to me simply marvelous, and yet there was not a good fit nor a decent joint on the whole thing.

This, however, is not saying that any arrangement of matter worthy the name of machine should not always be built in the best possible style, both of workmanship and material. I most certainly think that it should. What I wish to bring out is the uselessness of this "fine haired" ultra-measuring method as applied to job shops where a good proportion of the business is repair work—rough-and-tumble jobs in which nine-tenths of the people do not want to pay for fine work, even if they can get it. In a regular line of manufacture the correct—the *right* way is, of course, the only way; but for a mechanic in a job shop to worship the scale, calipers, gauge, rule, etc., too devoutly means simply starvation.

Not long ago I worked with a machinist who had the job of cutting off or beveling a piece of strap iron $1\frac{3}{4}$ inches by $\frac{5}{8}$ inch, two or three feet long. It was an extremely rough job, being merely a strip for riveting to the side of a stone-crusher to prevent fine stone from wedging into certain parts of the machine, the beveling being done so as to form an incline for the stone to slide over. I heard the man in charge of the job telling him, "On this side make it a little more than 45 degrees, but do not bring it down quite to a sharp edge. Leave it an eighth of an inch, or such a matter, wide." Well, after this machinist had worked an hour and a half on it, I went to see how he was getting along. He had it down to about $\frac{5}{16}$ inch, while around the planer lay scales and dividers and bevel protractors, with many other things too numerous to mention. He happened to be absent just at the moment, and as the cut was "down," I started a new one myself all "by guess." He kicked some when he came in, and said if the thing was spoiled it was my fault. But it wasn't spoiled. It came out a trifle less than $\frac{1}{4}$ inch, but was in every way just as good as though he had spent 15 or 20 minutes getting the exact depth of that last cut.

In such cases as this, I believe most emphatically that the phrases "good enough," and "just as good" may very well be applied; and would move to amend the proverb, "Whatever is worth doing at all is worth doing well," by adding the word *enough* to the end of it. For verily there are times in a machine shop when going beyond "well enough" is simply "casting pearls before swine."

I have seen machinists who, with chalk and dividers, would spend fifteen minutes getting the centers of a rough shaft, with a heavy cut to be taken off, when another fellow would have taken a center-punch

and hammer and in less than a minute marked it ready to drill, and have it good enough, too, which, in this case, means absolutely *good*, provided he has sense and judgment enough to gauge correctly the *probable* wabble the shaft will have after being placed in the lathe with the maximum of wabble allowable under the circumstances. This matter of judgment—the ability or gift of judging correctly of the relations existing between matter finished and unfinished, between the seen and the unseen, the known and the unknown, and of balancing cause with effect, or in other words, of knowing intuitively what another man would find out by a mathematical calculation—this gift seems to me to be one of the most desirable as well as valuable gifts a mechanic can possess.

I would not want in these few lines to be thought to advocate carelessness and neglect in the machine shop—nothing is farther from my purpose. I mean it only as a protest against the foolish practice of sacrificing time to exactness where exactness is not necessary.

ANTI-KNOW ALL.

What Is It Worth?

Editor American Machinist:

This thought came uppermost on reading your remarks on "Patents," in AMERICAN MACHINIST July 19th, and it appears to me that very much of the criticism of patents and the unfriendly feelings entertained by otherwise sensible good citizens is due to an entire misconception of "what a thing is worth." The idea seems to be that a thing is worth only what it costs to produce it, and that the selling price ought to be that, with, say, five or six per cent. added. In fact, the man who counts worth in that way, in his heart thinks the producer, if he is a patentee, ought not to charge profit at all.

It is pretty safe to say that *these* ideas of worth do not pertain to any other than patented things. If a man buys a horse, he never even thinks of gauging the price by the cost of production, but he looks solely to the ability of the horse to fill *his* wants. If he wants a violin, he knows that the $100 instrument cost the same to make as the $20 fiddle, but he does not cavil at that. If he wants a man to act as his agent, he does not hire the local weak-minded fellow, who has cost his parents much more than the young hustler who has already made a name for himself, notwithstanding the latter will want much more wages than the former, but if he wants a new machine which will turn out the things which he manufactures at one fourth their present cost, he is apt to set the price over against the cost of production, and call the inventor an extortioner. His mistake is fourfold. First, he does not figure in the preliminary expenditure while the inventor was devising and experimenting, and demonstrating the labor-saving capacity of the invention. Second, he does not figure in the benefit conferred upon the world through all time, perhaps, for which the inventor must gather in his compensation in seventeen years. Third, he does not figure the uncertainties of getting that reward even after his preliminary expenditures. Fourth, he does not figure his own profits in using the thing, and that if *they* were not substantial, he would not buy it at any price.

If I go to a manufacturer to procure a machine of my designing, and should demur to the bill because it amounted to 20 cents a pound for the cast iron, whereas I know the casting only cost him 2½ cents per pound, he would think me ignorant as well as unreasonable, and would, with some contempt for my understanding, inform me that, in addition to the cost of the casting, the bill covered drawings and pattern work, the making of some special tools, and machine shop work, and wear and tear, and 10 per cent. on all these. All of these and lots of them enter into the cost of every invention that goes on the market. And among the costs which it is reasonable to charge is the *uncertainty*. Every inventor *hopes* for fame and fortune, but few succeed in realizing these hopes.

I knew intimately a gentleman who had labored for several years to produce a satisfactory agricultural machine in a field where hundreds had failed. He succeeded. One of the largest manufacturers took the invention up, and put it on the market, where it created a revolution. In three years every rival manufacturer had on the market machines for the same purpose, and that circumstance reduced possible profits, but notwithstanding, he considered himself on the high road to fortune, and commenced to build for himself an elegant home. When, presto, something started a scare among the farmers, and whereas after several years successful use, one season many thousands were sold, and the next season *not one* was sold, and not one has been sold since.

It does not often happen that the transition is so sudden as that, but it often happens that the man who opens a new field, and revolutionizes an industry, finds himself outstripped by others, who are simply building upon his foundations. Cases of that sort might be found by hundreds.

You may ask how about your patents for revolutionizers? In these days of active thought, the discovery of absolutely new fields is as rare as the discovery of new metals.

Every inventor finds that others have been delving before him—they have not succeeded in finding the gem, but they have come dangerously near it, and it is very seldom that it is possible to procure a patent broad enough to shut off ingenious imitators. Added to this, it must be considered that the inventor seldom comprehends fully his own invention, and it hardly can be required of a solicitor that he shall comprehend more than the inventor. Yet, as a rule, an able solicitor very often does comprehend more than the inventor. If it were not so, the number of adequate patents would be still smaller.

R. D. O. SMITH.

A Straight Line Motion.

Editor American Machinist:

The straight line motion, shown in Figs. 1 and 2, has been suggested to my mind by the study of the relations of the pole and polar with respect to a circle *

The pieces $A\ a$ and $B\ b$, Fig. 1, move independently on a common center o. The rods a and b (shown to better advantage in Fig. 2) are cylindrical, the axes of which must be perpendicular to the center lines of A and B, which should be of equal length.

The sleeves c and d, jointed at e, are bored to fit the rods a and b, and are free to slide on them in the direction of their axes.

The straight link C, which vibrates on a fixed center o', controls the positions of the pins f and g by means of sliding blocks; the centers of these pins and the center o' being, by this device, always in the same straight line. If motion be imparted to this combination the pin e will be compelled to move in a straight line perpendicular to the line of centers $o\ o'$.

ANALYSIS OF THE MOTION.

If we take any point o', Fig. 3, within a circle, and draw any chord, the locus of the intersection of the tangents at the extremities of this chord is a straight line $a\ b$ perpendicular to the line joining the center o and the point o'.

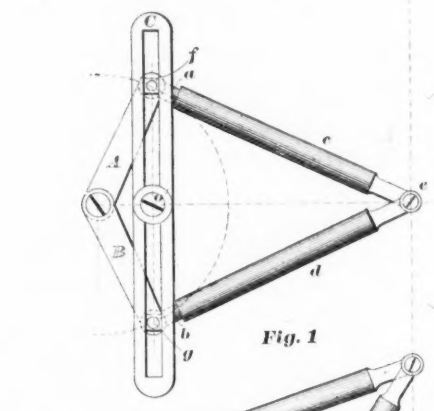


Fig. 1

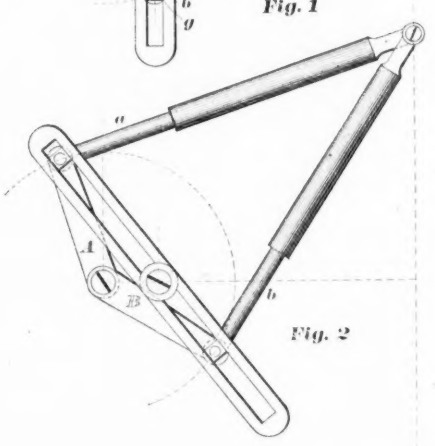


Fig. 2

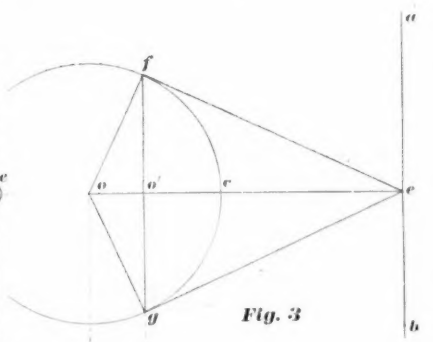


Fig. 3

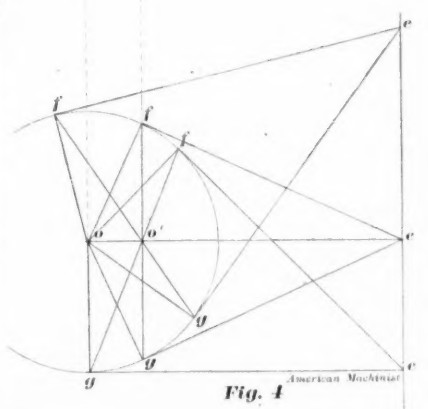


Fig. 4

STRAIGHT LINE MOTION.

Fig. 4 illustrates different positions of the chord $f\ g$ drawn through the common point o', and the two tangents in each case perpendicular to the radii drawn to the extremities of the chord.

The reader will see the connection between Figs. 1, 2, 3 and 4. In Figs. 1 and 2, the line joining the centers of the pins f and g corresponds to the chord $f\ g$, Figs. 3 and 4, which always passes through o'. A and B must be of exactly the same length, since their center lines are radii of a common circle; and the axes of the rods a and b should be perpendicular, respectively, to A and B in order that they may correspond to the tangents to this circle.

The point o' and the straight line $a\ b$, Fig. 1, are called the *pole* and *polar* with respect to the circle. The position of the polar $a\ b$ may be determined without drawing the tangents as follows: Make $o\ e$ a third proportional to $o\ o'$ and $o\ c$, *i. e., the square of the radius of the circle* ($o\ c^2$) is equal to the product $o\ o' \times o\ e$.

The polar may be determined on the drawing board without calculation as illustrated in Fig. 3. Draw the chord $f\ g$ perpendicular to $o\ o'$. Draw $f\ e$ and $g\ e$ perpendicular, respectively, to the radii $o\ f$ and $o\ g$, intersecting at e; $a\ e\ b$ perpendicular to $o\ e$ is the polar.

F. R. HONEY.

Making a Worm Wheel Pattern.

BY A. L. BOWEN.

The making of worm wheel patterns has always been somewhat of a bugbear to me, but some time back I was obliged to make one, and I decided on the plan that I shall describe: The wheel in question was 19-inch pitch diameter and had 48 teeth, concave face to conform to the worm which was about 5-inch pitch diameter. As the method of making the worm was fully described by another writer, I will confine myself to the wheel, the construction of which I think may be new to some of your readers, as it is to me. The results obtained were highly satisfactory, in fact, I have seldom seen a *cast* gear that would stand as critical an examination as this. For although such inaccuracy would be intolerable in a *cut* gear, my experience has been that most cast gears are fully as bad if not worse than this. I set my calipers to the outside of the first and third tooth, and had a gauge so that the calipers always touched the same circle. I found no variations exceeding .02 inch and the diameter varied less than $\frac{3}{64}$ inch. I have seen *patterns* that had greater errors. The form of tooth was the involute, and I will say here that I believe that form for most purposes is the best.

This pattern, instead of having the teeth in the pattern, had a core print the same as is sometimes used in making sheaves, and the teeth were made in dry sand. Fig 1 is an elevation of the pattern and Fig. 2 a cross section. R being the body of the wheel and O the core print for the teeth. Fig 3 shows a longitudinal cross section of the core box. Fig 4 vertical section. The box is open top and bottom and is one sixth of a circle, the side L being doweled onto side M at $a\ a$.

The central tooth G, Fig. 3, is fastened permanently onto the part M, likewise the half teeth I and H. The three teeth C, C, C are fastened onto the part E, the teeth D, D, D onto the part F, these parts being nicely fitted and perfectly loose, *i. e.*, free to push out but no play. A $\frac{3}{4}$ inch hole is bored in M at b and b', and a large wood screw screwed into parts E and F. These may not be needed, but better be put in. Now, in the making of the core, the box is laid on the core plate and a core rammed up; then the box is turned up on the bench with the side M uppermost and this part lifted off, the parts E and F remaining in the sand, but should they stick a little rap lightly on the screw heads b and b'. After these have been drawn out, the core may be laid on its side on the core plate and is ready for the oven. The advantage I see in this method is that the pattern is more easily made and is vastly more durable when done. The molding is extremely simple, requiring probably less than an hour, including the core making. Besides all that, if you want to change the pitch, or change from right to left-hand, or make straight face instead of concave, you only have the core box to make.

Now, just a word about core boxes and core prints. I have heard a good deal of talk about cores expanding in drying, but I must confess that I have never had a case of expanding cores come under my observation, though I have seen lots of misfit cores. This was generally due to misfit core boxes, though sometimes to careless core-making. But when I see a patternmaker jam a pair of calipers down over a piece he is turning up in the lathe, and then when he turns up the core box, caliper that with a crooked two-foot rule, I don't blame him for saying cores expand—he ought to say something. A man should caliper lathe work in wood the same as in iron, and it requires just as fine a touch to get good results. In my opinion, the two foot rule will do to guess with, but a steel scale only should be used to measure with.

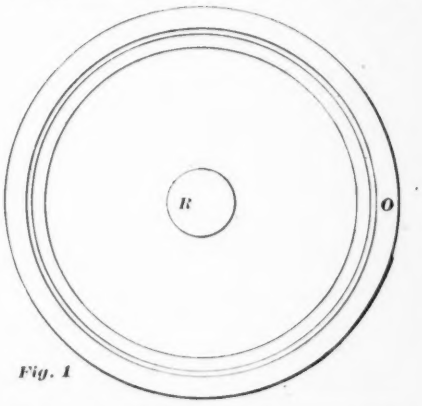


Fig. 1

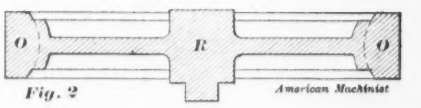


Fig. 2

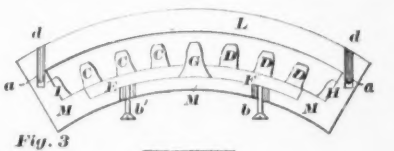


Fig. 3

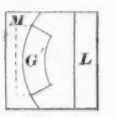


Fig. 4

MAKING A WORM WHEEL PATTERN.

*See Chauvenet, Elementary Geometry, Appendix II. Introduction to Modern Geometry, page 349, *seq.*
Or Newcomb, Analytic Geometry, page 94, *seq.*

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Premiums on War Ships.

The recently earned premium of over $400,000 by the Cramps for excess speed of the "Minneapolis," has caused some comment upon the premium business again, and a Philadelphia paper gives a table showing that on seven naval vessels built at Cramps, premiums amounting to $1,271,224.50 were earned. This seems like a very large amount, it is true, but when we reflect that it is slightly less than 10 per cent. of the contract price of the vessels, it does not seem so large, especially when it is considered that the vessels are certainly much more than 10 per cent. better for their intended purpose than they would have been, had they just barely come up to the contract requirements as regards speed. It is probable, too, that the actual cost of the work required to give the increased speed capacity was at least a fair proportion of the premiums.

There is still another way to look at the matter. We do not believe that any shipbuilding firm in the country would contract for the high speed attained in the "Minneapolis," for example, with the penalty for failure set up squarely before them. With the prospect of a substantial gain and the credit going along with it, they are willing to take the chances of expending a good deal more in the construction, covering every little possible point of gain. The result is that the government gets a good deal better vessel, gets all it pays for, and the builder makes some money, but by no means, as appears to be thought, the sum represented by the bonus he receives.

It is probable that had the contract speed of the "Minneapolis" been fixed at the speed she actually attained on her trial trip (a little over 23 knots), with a penalty of $50,000 for each quarter-knot deficiency, the contract price, under the conditions of competition existing when bids were received for her construction, would have been at least as high as will now have to be paid in contract price and premium together.

Science of Steam Engineering.

A correspondent writes us as follows: "Why do you write about the science of steam engineering, when there is no such thing? The steam engine of to day in all its parts is the creation of practice, and there is nothing of science or theory about any of its parts."

We have much respect for our correspondent's views, but if at any time we have written, as we presume we have, of the science of steam engineering, we hope it has been advisedly. There seems to be a rather loose acceptation of the words science and theory, as if they were something rather to be shunned by the average man. There is nothing in science and nothing in theory that the practical man may not help establish, in fact, nothing that he has not been mainly instrumental in establishing. But all this has been discussed again and again without profit.

We presume our correspondent means us to understand that his opinion is that the proportions of the parts of the steam engine have been determined by practical experience rather than by the use of figures that it might have seemed possible to have applied. If this is his meaning, he is undoubtedly right. It must be admitted that the dimensions of about every important part of the steam engine have been arrived at by tentative processes, and that the formulas used in the proportioning of these parts have been constructed after the determination of these proportions by tentative processes, and not before.

But why single out the steam engine? This is exactly the case with every important machine, and in the nature of things, always must be. But this of itself is nothing against the formulas. If our correspondent, without previous experience or knowledge in the matter, were to set to work to design a steam engine, to keep to his example he would, if he were wise, find out what others had done in that direction. It would be rather inconvenient to go around measuring other people's steam engines, so he would consult some good work on the subject and find rules there which had been framed from a consideration of the successful experience of men in building steam engines. Then, very likely, if he went into the business of building of steam engines, his practice would lead him to substitute rules of his own in very many cases, and perhaps some one would get these into a book, and so with others, which accounts for the rather puzzling diversity of formulas, even when the best authors are consulted.

Contractors find a great convenience in being able to rent almost any kind of machinery they may require in most large cities. This is particularly true in regard to small jobs in outlying towns, taken by contractors living, perhaps, a thousand or more miles away. A hoisting engine, for instance, is required for a short time, and it is cheaper and more convenient to rent one near at hand than to bring one from the distance. And so with other things that may be needed.

Good, stiff prices are charged by those who keep such machinery for rent. For example, we know a contractor who wanted a steam pump to use on a job a few miles away from New York. He readily found what he wanted in New York. When new this pump might have been listed at $250, although that would have been a round price. At second hand, as it was, it would hardly sell for $150. It was rented one month for $60. This looks like a high price, but such rented machinery is generally pretty hardly used, and this pump would be likely to go back in need of a rather thorough overhauling and the renewal of some of its parts, and, perhaps, not be rented again for a year, so that after all the rent was, probably, not exorbitant. Other machinery was charged for at proportionately rather lower rates, it apparently being taken into consideration that the pump would get the hardest usage, which was true enough, as it handled about as much sand as water.

The foreman for this contractor—a veteran in the business—informed us that the laborers employed were all Italians, obtained from a padrone, to whom he paid one dollar and a half a day, the padrone paying them considerably less. Irish labor, he said, would have been cheaper at a dollar more per day. The price paid by the laborers for board, the foreman said, was four dollars a month. It seems almost incredible that hard-working men could be kept alive for this sum, and probably the quality of their food had something to do with their inferiority as compared with men better fed.

This brings to mind the fact that the past fifteen years has worked almost a revolution in the labor market in this country. Formerly, the laborers here were for the most part men who came to make homes in this country and become citizens. But this has been gradually changed by the importation of laborers who are not their own masters, and have no intention of becoming citizens. They have no interest whatsoever in the country except as it is a place where they can earn better wages than in their own countries, to which they expect eventually to return and spend their accumulations. It scarcely requires argument to demonstrate that this is not the best thing for the country; the undesirableness of emigrants who do not come to this country with the intention of becoming citizens has been repeatedly shown by riots and lawless proceedings in various places. American labor should not be forced to compete with men who live on four dollars a month.

There is in about every large city in the country a question as to the quality of the water supplied for drinking and for culinary purposes. Common-sense people see the source of the water supply, and they see what comes from the water taps, and they pronounce it indecent. But then comes in the reports of *ex parte* scientists who fail to find "nitrates," and all that, and the assumption is that common mortals ought to be satisfied. Who, to be sure, can bandy symbols with men who are brought up on symbols? But, notwithstanding all that the experts may say, the people in most large cities believe that their drinking water is beastly bad. Away from cities there is a way to get good water. But the water that people are compelled to drink in the cities of this country would eternally disgust the average countryman if he could once see whence it came.

Literary Notes.

One would think that every publisher of school text-books, to be used in the instruction of children, would feel a peculiar responsibility regarding the elimination of errors from those books. Many of them do feel this responsibility, but that there are those who do not, is plainly shown by a pamphlet recently issued by the Pope Mfg. Co., Boston, giving the results of their second competition for prizes (Columbia bicycles) awarded to persons finding the greatest number of errors in school text-books. There were 162 competitors and six prizes were awarded. The total number of errors claimed was 5,360, of which 673 were admitted by the authors and publishers of the books, with the statement by the latter that plates would be changed and errors corrected as soon as possible. But 1,573 errors were claimed, regarding which the publishers of the books in which they occurred declined to enter into any correspondence, ignoring repeated requests to either acknowledge or deny the existence of the errors claimed. These were, as might be expected, the publishers of the books containing by far the most errors.

Of course, it is conceivable that there are publishers who are narrowminded enough to object to criticisms brought about by what might be regarded as an advertising scheme, but the most probable reason for these publishers' action is simple boorishness and indifference towards the high responsibilities assumed by them.

It would seem as though it were time a competent authority were given the power to see that school books were free from plain misstatements of facts, and the Pope Company is entitled to all the free advertising it can get out of its work in showing what the condition of affairs really is. We regret, however, that the names of the publishers who have thrown obstacles in the way of the investigation are not given in the pamphlet.

THE ENCYCLOPEDIA OF FOUNDING AND DICTIONARY OF FOUNDRY TERMS USED IN THE PRACTICE OF MOLDING. By Simpson Bolland; Practical Molder and Manager of Foundries; author of "The Iron Founder," "The Iron Founder Supplement," etc.

Molders, and all desirous of becoming acquainted with foundry terms, will find this work to be an extremely useful and reliable one. Its pages give ample evidence that it has been written by one who is thoroughly conversant with foundry practice and all its details, and competent to convey his ideas to others in a manner which cannot fail to make the book a popular and valuable one in the hands of molders.

The author gives not only the meaning of various terms, but also describes the tools, mechanical application, materials and methods employed to produce castings in many of the useful metals and their alloys, including brass, bronze, steel, bell, iron and type founding; with original mixtures of recognized value in the mechanic arts. The book also treats in a very concise manner on aluminum, plating, gilding, silvering, dipping, lacquering, staining, bronzing, tinning, galvanizing, Britannia ware, German silver, nickel, soldering, brazing, ores, smelting, refining, assaying, etc.

The terms are arranged alphabetically, and the top of the pages indexed so as to facilitate the finding of any word or term relating to foundry practice. The work supplies a deficiency in the literature relat-

ing to the art of molding, and will be a valuable addition to scientific libraries. It is published by John Wiley & Sons, 53 East Tenth street, New York. Price, $3.00.

Questions and Answers.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(368) J. M., Brooklyn, N. Y., writes: In order to decide a bet, please answer the following: A. says that a steam pipe resting on wood will cause the latter to take fire. B. says the wood will not take fire. Who is right? *A.*—Should the steam become superheated there is danger of the wood taking fire. It is bad practice to allow steam pipes to rest on wood in any case, and should always be avoided.

(369) H. F. R., Elgin, Ill., writes: In computing the torsion of a line shaft, with bearings at the ordinary distances apart, does the length of the shaft make any difference, that is, from where the power is applied to where it is taken off? *A.*—Shafts may be strong enough to resist twisting, but they may not have the required stiffness, that is to say, the angle of torsion may be too great for the work the shaft has to perform. In such cases it is necessary to choose a permissible angle of torsion. But this angle depends upon the length of the shaft. Hence we may say that when the strength only of the shaft is to be computed we do not take its length into account, but when the stiffness is to be computed, the length of the shaft cannot be neglected. 2. Where can I obtain any information in regard to subjects of this kind? *A.*—"The Elements of Machine Design," by W. C. Unwin.

(370) J. F., Pullman, Ill., writes: Please help me out on the following subject: What should be the size of the steam ports for a high pressure cylinder 2 inches diameter and 4 inches stroke, also for low pressure cylinder 4 inches diameter; the engine is to run at a speed of 350 revolutions per minute? *A.*—Steam ports in high-pressure cylinder $1 \times \frac{3}{16}$ inch; steam ports in low-pressure cylinder, $1\frac{1}{4} \times \frac{3}{16}$ inch. 2. What will I gain by using the low-pressure cylinder? *A.*—The engine will run steadier, and there will be a small saving in fuel. 3.—I intend using a horizontal tubular boiler, and build a sheet iron furnace under its bottom, and extend it around one half of the circumference and return the heat through the tubes. My idea is to get more heating surface for the weight, I intend to use the boiler on a launch. *A.*—This is dangerous practice, as there is a liability to set the boat on fire, and also a liability to burn out the sheet iron. If this design is insisted upon we should prefer to use cast-iron in place of sheet-iron, lined with asbestos.

(371) A Reader writes: If we have a piece of machine steel 12 inches long, held in a lathe chuck at one end and a steady rest at the other, and if we are to drill a hole through this piece with a drill 15 inches long $\frac{1}{4}$ inch diameter, will this drill have any more tendency to "run out" or drill an untrue hole if the chuck in which it is held in the tail-stock spindle be thrown out of line as much as possible by setting the tail-stock over? *A.*—There is no reason why it should run out under these conditions more than if in line, except what may be called accidental reasons. That is to say, if the steel to be drilled were absolutely even and uniform throughout and the feed were the same, it probably would drill as true as if in line; but since in this condition the drill would be under a strain tending to keep it to the center of the revolving work—a strain opposed by the drill, since it must be deflected in order to keep in the center, variations in hardness or uneven movements of the tail stock screw would, we think, have more tendency to throw it out than they would have if things were in line.

(372) A. W., —— Pa., writes: Please explain the meaning of the expression "allow $\frac{1}{2}$ per cent. for strainage." This expression I have seen used in connection with foundry practice. *A.*—We understand the word strainage to mean, when used in connection with foundry practice, the tendency of the casting to become larger than the pattern, due to the liquid pressure at the time of casting. Cast plates are frequently thicker than the pattern. If, now, the weight of the casting is computed by the dimension on the drawing and the pattern is made to the drawing, then $\frac{1}{2}$ per cent. of the computed weight should be added to the estimated weight so as to obtain the actual weight. In short, the above expression means the weight which must be added to the estimated weight to obtain the actual weight of the casting. 2. What influence has the water used in making the mold on the metal which fills the same? *A.*—The moisture in the mold will impair the finish of the casting, and make the mold less porous, subjecting it to a liability of injury from the gases generated on the surface of the mold.

(373) D. M. W., Binghamton, N. Y., writes: Kindly inform me what process is employed for browning shot gun barrels. *A.*—A variety of colors on iron and steel can be produced by means of a mixture of lead acetate and sodium thiosulphate. The following proportions may be used, with the results enumerated below, the colors altering with the time of immersion: Lead acetate, 50 grains; sodium thiosulphate, 50 grains; water, 5 fluid ounces. The solution must be used hot. 1. Light brown color. 2. Darker brown color. 3. Purple and blue mixed. 4. Purple and blue paler tone. 5. Uniform light blue color. 6. Steel gray. 7. Black color, after half an hour's immersion. In order to produce a uniform color all over, the article must be completely immersed, so as to be equally heated. Another way is to dissolve in 4 parts of water, 2 parts crystallized chloride of iron, 2 parts chloride of antimony, and 1 part gallic acid, and apply the solution with a sponge or cloth to the article, and dry it in air. Repeat this any number of times, according to the depth of color required. Wash with water, and dry, and finally rub the articles over with boiled linseed oil. The metal thus receives a brown tint and resists moisture. The chloride of antimony should be as little acid as possible.

(374) A. D. C., ——, asks: What constitutes a commercial horse power, or is there any standard rated value for an actual continuous horse-power? What should a consumer pay per horse power for not less than 50 horse-power, the power to be delivered to shafting continuously every day except Sundays and holidays, 10 hours per day? *A.*—This is a question that is not easily answered to cover all cases. At the recent Montreal meeting of the American Society of Mechanical Engineers, Decourcy May read a paper on the "Cost of an Indicated Horse-power." In this paper other authorities are quoted showing the cost of an horse-power to be $50.99 to $51.75 per annum for 365 days of 24 hours each. Mr. May's figures give the annual cost of an I. H. P. for 308 days of $10\frac{1}{4}$ hours when coal is $2 per ton of 2 240 pounds at $49. With coal at $3 per ton, $53; coal at $4 per ton, $57; coal at $5 per ton, $62 This is for a non condensing engine 50 to 200 horse power. The value of land occupied and other local conditions have much to do with it, however, the actual cost, and, therefore, the amount which a power user should pay depending largely upon these local conditions. In discussing the paper mentioned Mr. A. A. Cary said he had figured the cost at $55 to $60 per year (10 hour days) in New York City and had sold power on that basis.

(375) M. S., Newport, Ky., writes: I would consider it a great favor if you will describe an incubator to be heated by a lamp. *A.*—The incubator consists of rectangular case usually supported by four legs, giving it the appearance of a table with a very deep top A lamp is suspended from the bottom of the case, from which the heat ascends through a small flue into a hot air tank. This tank is placed near the top of the case, is rectangular in form and extends nearly throughout the length and breadth of the case. The tank is very shallow, so as to allow sufficient room underneath it for a tray holding pans of water, and for the egg trays which are placed near the bottom of the case. The hot air tank is connected to an automatic regulator or thermostat. These are the principal features of an incubator. There are different kinds in use, but they are essentially alike in principle, namely, they comprise a case containing one or more drawers or trays for holding eggs, some form of hot water or hot air apparatus (usually a lamp for heating) and, in the most practical forms, a thermostat of some kind for regulating the temperature, besides ventilators, appliances for saturating the heated air in the interior with moisture, etc. Some incubators are also fitted with appliances for turning the eggs without opening the machine. You will find an illustration of an incubator in the "Century Dictionary."

(376) H. G., Philadelphia, Pa., writes: Please inform me which of the following calculations is correct: A tank whose volume is 42.5 cubic feet was by actual test pumped up with air to 80 pounds pressure in 6.5 minutes, the compressor running at about 140 revolutions per minute; intake cylinder 11 inches diameter 6 inches stroke (single acting). To find the number of cubic feet of free air I divide 80 by 14.7 = 5.5 and multiply 42.5 by 5 5 = 233 75 cubic feet of free air contained in tank. This amount I divide by 6 5 = 36 cubic feet of free air delivered per minute. In the same test, however, 20 pounds pressure were obtained in 40 seconds, which by the same calculation would give 56 cubic feet, which cannot be right. Am I to subtract 42 5 cubic feet from the total amount of free air in the tank, as calculated above, for the two stages of compression? In that case I do not get the same amount of free air delivered in both cases either. In one case I make it 29.4 cubic feet of free air per minute, and in the other but 22 311 which seems altogether too low. Any information on the above subject will be much appreciated. *A.*—The rule you have adopted for computing the amount of free air forced into the tank is correct, but we are inclined to believe that the given pressure is gauge pressure, in that case your computations are wrong, because absolute pressures should be used. The absolute pressures are obtained by adding 14.7 pounds to the gauge pressure. To state the rule in symbols let p = absolute pressure in pounds per square inch in tank, v = volume in cubic feet in tank, and c = volume of free air. We then have

$$\frac{p \times v}{14.7} = c,$$

substituting for the symbols their values

$$\frac{94.7 \times 42\ 5}{14.7} = 273.7 \text{ cubic feet}$$

of free air delivered into the tank when the gauge pressure is 80 pounds per square inch. For a pressure of 20 pounds in tank we have

$$\frac{34\ 7 \times 42.5}{14\ 7} = 100.3 \text{ cubic feet.}$$

of free air delivered into the tank. This shows that more free air in a given time can be delivered into the tank at low pressures than at high pressures. This is due to the fact that in all air cylinders there is clearance between the cylinder heads and piston, and the higher the pressure in the clearance the less free air will be drawn into the cylinder.

(377) C., ——, Ind., writes: I obtained the book on valve gears by F. Halsey, which you recommended. I find it to be a very good book; it shows how to design a valve for a given cut-off, release and compression, how to analyze an existing valve, gives areas of steam and exhaust ports, etc., etc., but not one word is said in regard to the design of a valve which shall distribute the steam economically, that is, it does not say where steam should be cut off, where release and compression should take place; the book simply gives rules for laying out the valve after these points have been determined. What I am after is to know how these points are determined in the first place; or, if I am called upon to examine a plain slide valve engine, and to determine whether or not its valve is constructed so as to use steam economically, by what rules shall I be guided? *A.*—The exact points of cut off, release and compression for the most economical distribution of steam cannot be given. Experimentally, it has been found that with steam from 70 to 90 pounds by gauge the best economy in a non-condensing engine is obtained when the load is such that the cut-off will be not much, if any earlier than one quarter stroke. With this cut off the terminal pressure will be from 5 to 10 pounds above atmosphere. At lower steam pressure than named, the cut-off should be later. With condensing engines the cut-off may be such that the terminal pressure will be at atmosphere, or, a little below. The release should occur a little before the end of the stroke so as to reduce the back pressure to a minimum. The compression should not exceed the pressure in the steam chest, in fact, a little less compression will generally give better results. If compression is carried too far a loss is likely to occur from a springing up of the edge of the valve, permitting steam to blow through into the exhaust. The tendency is also to wear the valve in such a shape that it will leak. Compression will seldom be as high as would appear from calculation, owing to heat being rapidly taken up to warm the exposed surfaces of the cylinder. At high speed compression will be higher than at low speed, because there is less time for the transfer of heat, and because the back pressure is generally higher at high speed. The best way to determine whether or not a valve is correctly designed for the work it has to do, is to attach an indicator, as a loss of steam may be due to other causes than to the valve. From the foregoing, it will be seen that there are many conditions which determine the correct positions of cut off, release and compression, and to know how to locate these correctly, considerable experience is required. "Indicator Practice and Steam Engine Economy," by F. F. Hemenway, will be of great assistance to you; it is published by John Wiley & Sons, New York. This book and "Slide Valve Gears," by F. A. Halsey, make good companion books.

Business Specials

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Cleveland, Cleveland, Cleveland, Grant, p. 12.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Turret Drills, 6 spindles. A. D. Quint, Hartford, Ct.

"National" Lathe Chucks. Best made, page 15.

Pattern and Brand Letters. A variety of sizes and styles. Heber Wells, 157 William St., N. Y.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Improved Duplex and Special Gear Cutters in stock and to order; Gear and Milling Cutters of all descriptions. R. M. Clough, Tolland, Conn.

"Pumping Machinery." New book, 450 pp. 8vo, 270 Eng. Prospectus free. W. M. Barr, 3223 Powelton avenue, Philadelphia, Pa.

New Jersey Art Metal Co., Passaic, N. J., finest thin and ornamental castings in brass, bronze, aluminum, etc.; machinery name plates in brass and aluminum.

Grinders' Supplies—Emery, emery wheels, grinding machines knife powders and sharpeners, paste and liquid polish, whetstones, etc., etc., quick process and large stock. Customers annoyed by the delays due to long processes and small stock can get goods in a hurry by buying of The Tanite Co., N.Y. City, Cincinnati, O., and Stroudsburg, Pa.

"Binders" for the American Machinist. Two styles, the "Common Sense," as heretofore sold by us and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. American Machinist Publishing Co., 203 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 post paid. Published by John Wiley & Sons, 53 East Tenth street, New York.

A New Steam Fire Engine.

We illustrate on page 10 a new steam fire engine that is being put on the market by the American Fire Engine Company, of Seneca Falls, N. Y., and Cincinnati, O., giving along with the perspective view some of the details which will help to a better understanding of the general construction.

The boiler adopted for use with this engine as shown is what is known as the Clapp coil tube boiler, modified by the engine company to better suit its requirements. As will be seen, the more noticeable feature of this boiler consists of spirally coiled water-circulating tubes, arranged in a way that practice has shown to be best for their purpose. These spiral coils are made from seamless copper tubing, and their arrangement is such that expansion and contraction is provided for without the straining of joints. The spiral pitch or bend of each tube is such as to permit of the employment of five others of equal diameter; that is, there is in each circular row six of these coil tubes, the number of rows employed, and the diameter of the tubes depending upon the size of the boiler.

Each of these coil tubes is connected at its upper end with the crown sheet and at its lower end with the fire-box wall, so that the water in circulating always flows over the crown sheet, thereby avoiding liability to overheating. The connections at the ends of tubes are made by means of jam nuts and corrugated copper washers, which, there being no undue strain on the tubes, is found to result in absolutely tight joints, while at the same time it admits of the ready removal of the tubes, should this be required for repairs.

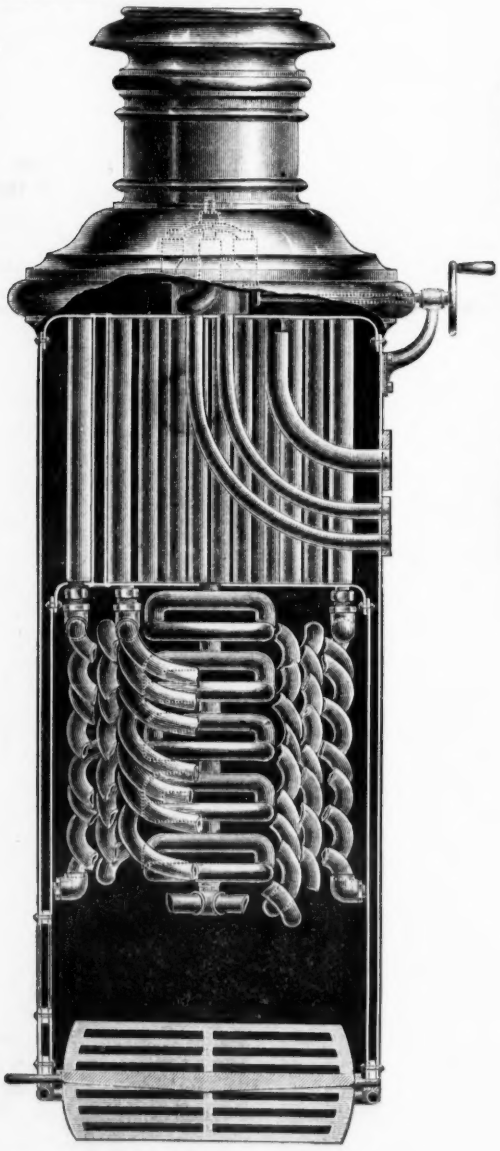
The working of the boiler may be explained as follows: The fire being started in the fire-box, almost immediately the water in the coil tubes becomes warm and begins to circulate, as a natural result, the heated water passing up into the steam drum, and the cooler water from the leg and drum taking its place, the whole being quickly heated to the steam-making temperature. At this point pressure begins to show, and increases very rapidly, since the circulation is constantly maintained and the water is all at the same high temperature.

While it is preferable, of course, to carry

the water a few inches above the crown-sheet, as thereby a more uniform pressure of steam may be maintained, which is always desirable, yet the limit of safety is not reached until the water is nearly all out of the boiler, or lower than the coil connections in water leg. Even with the level of water below this point the only danger would be from possible injury to the coil tubes, resulting from excessive heat while the tubes were unprotected by water.

Although these coil tubes are rolled spirally to as small a size as possible, there is still left a space of considerable diameter in the center of the fire-box. The tendency of this space, if left unoccupied, would be to act as a flue, causing an excessive amount of heat to pass up through the central fire tubes, resulting in their undue expansion as compared with the other tubes and loosening the joints of the latter in the top or head of boiler.

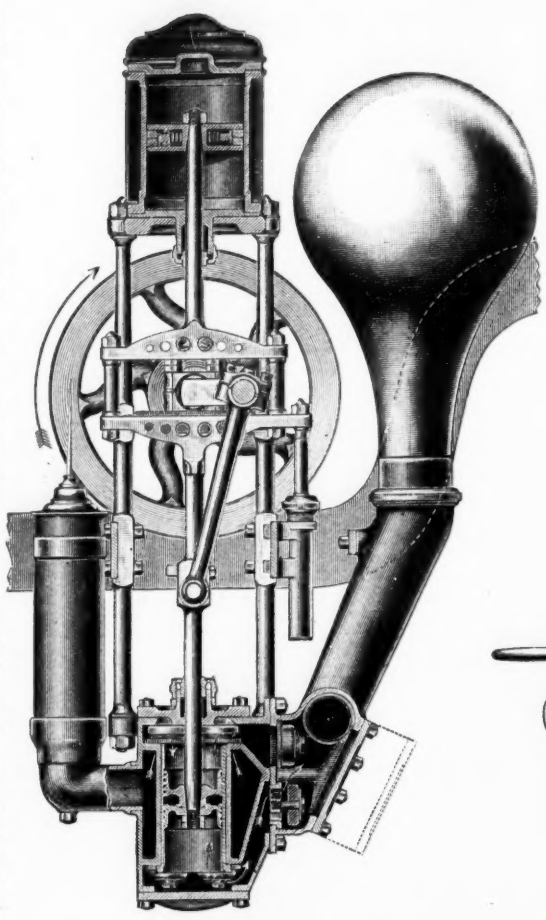
To overcome this difficulty, as well as to effect a more uniform passage of heat through the fire tubes, direct the gases of combustion in more effective contact with the coiled water tubes, and at the same time provide additional water circulation passages and heating surface in the hottest part of the fire-box, there has been devised an improved water circulating fire deflector, adapted to occupy the space in the center of the fire-box within the coil tubes.

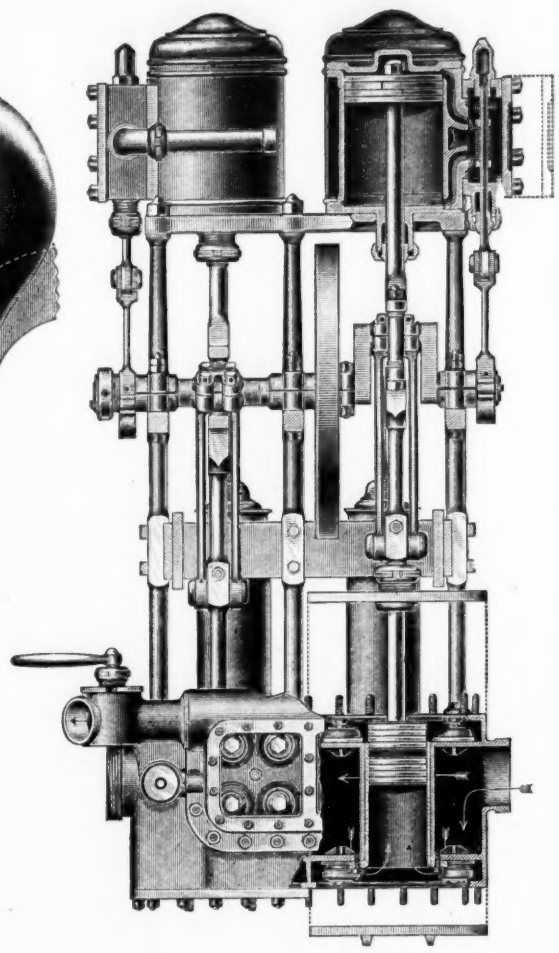


The design of this water-circulating fire deflector is clearly shown in the illustration of boiler. It consists of a number of sections which are connected in series vertically so as to reach from the crown sheet, into which the deflector is screwed, to the bottom of the spiral coils, where connection is made with the water leg of the boiler.

Extending from the crown sheet to the top or head are the smoke flues or fire tubes securely expanded at both ends, through which the gases of combustion pass from the fire-box to the smokestack, and which also serve to superheat the steam.

The pump adopted by this firm, as shown, is of the double-acting type, designed by Mr. Charles H. Fox, of the Cincinnati works.





The pumps are united in a gun-metal casting, which forms a single body for both, and permits them to be placed much closer as to centers than could otherwise be done. This method also obviates any weakness in construction attending a connection between separate pumps, and provides an ample suction chamber which is common to both. In cross section, as shown by Fig. 2, the pump somewhat resembles a box girder. This peculiarity of the pump's combined form furnishes a rigid base for the entire structure, simplifies the driving mechanism and enables it to endure heavy strains without vibration.

In providing facilities for the exposure of the pump's interior mechanism, the prime importance of perfect water-ways has been fully recognized; in fact, the proper arrangement of such was made the basis of the design, and it is apparent that in no manner have the passages been distorted or diverted into unnatural directions for the purpose of securing such facilities; an advantage that will be at once appreciated. Every detail of the interior of the pump is quite accessible. Thus any of the valves can be readily examined and replaced, if found necessary. All joints that must be broken for this purpose being planed, flat surfaces.

There are a good many other important features pertaining to the construction of this engine, which for lack of space we do not particularize. We may say, however, that it appears to have been the intention of the manufacturers to look sharply after the various features of detail that taken together make a successful whole.

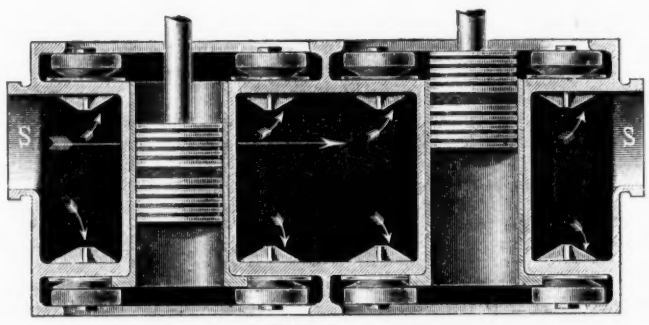


FIG. 1.

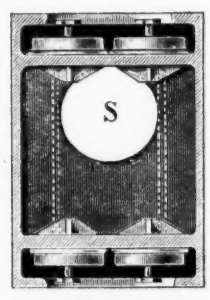


FIG. 2.

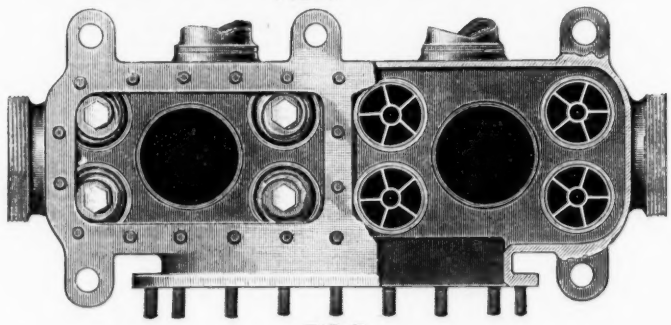
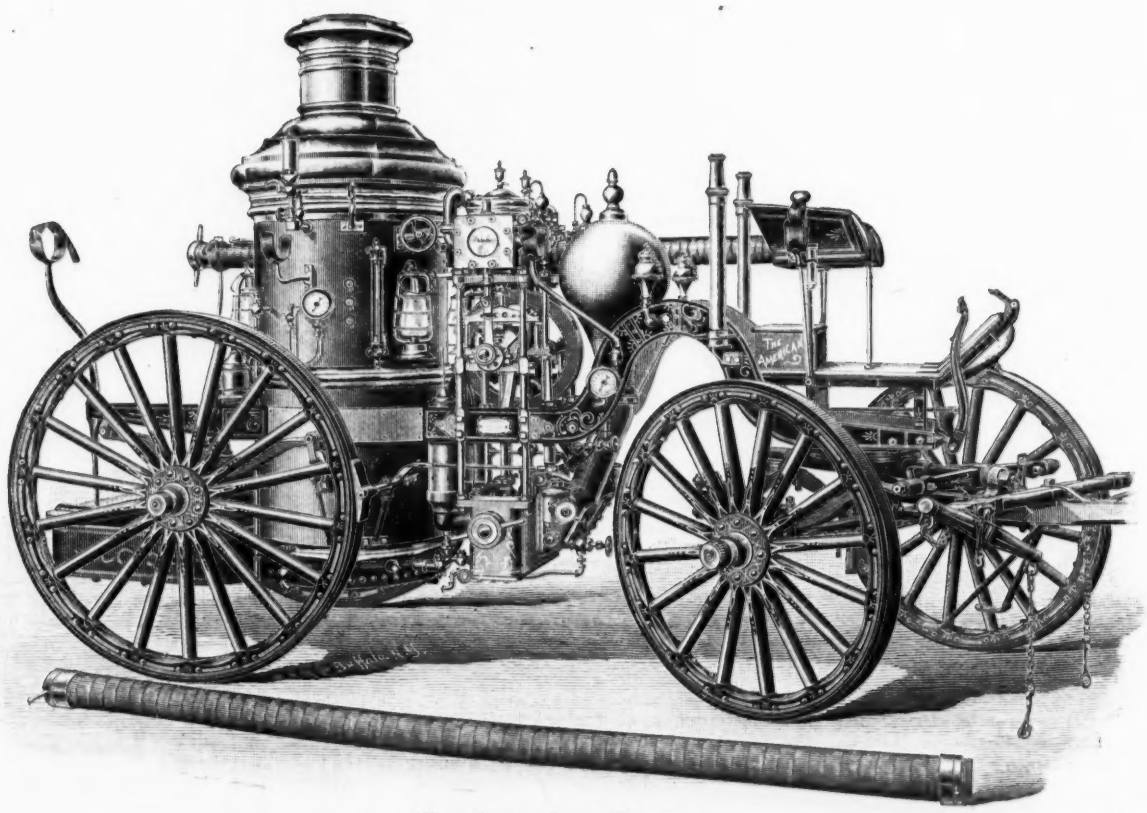


FIG. 3.

REMOVABLE LINING FOR PUMP BARREL.

Cannot Compete With Convict Labor.

It is announced that the jute mills at Oakland, California, are to be permanently closed. Most of the looms and spindles and all of the spool machines are already idle. A large number of Chinese and Portuguese will be thrown out of employment. The mill was unable to compete with the convict labor employed in the prison jute mills at San Quentin.



New Steam Fire Engine.

Blowing Engines.—I.

In our issue of October 26, 1893, we published a paper read before the Mining Engineering Division of the World's Engineering Congress at Chicago, by Julian Kennedy, of Pittsburgh, Pa., on "Blowing Engines." As the discussion on this paper embodies some matters of interest we herewith reproduce it in full:

DISCUSSION.

F. W. GORDON, Philadelphia, Pa.: There can be no objection to the use of the cross-compound blowing engines, and when they are condensing they are susceptible of great range of duty with slight loss in efficiency. By those who have use for the full heat of the waste gases, this type of engine is advantageous, but many furnaces are not so located. The pig-iron is their finished product, and the gases are to be employed only for furnace use. In this case simple engines are preferable, being less expensive and having less parts to take care of. These reasons determined the introduction of the engines, a sketch of which is distributed at this session. There are three of these engines to furnish blast for two furnaces, for a make of about 250 tons per day, using 75 per cent. anthracite and 85 per cent. magnetic ores, and they are expected to blow up to 20 pounds pressure per square inch.

For blast furnaces I prefer the single to the coupled engine, except in compounding. The engine presented is practically the same as half of that presented by Mr. Kennedy, except in detail.

Our inlet valve is double-ported and placed inside the cylinder, whereby it works under less constant pressure and has less motion, while the increase of clearance is but half of 1 per cent. These valves have each 452 square inches area, which, for the limited piston speed of 360 feet, is ample.

The outlet valve openings in the head are 6 inches in diameter, and there are 36 in all—18 in each end. The valves are very light, of phosphor bronze, have flat seats and slide on fixed stems. The valve's center of gravity is in the line of the seat, to avoid a tendency to cant. The end of the stem is a collar 2¾ inches in diameter, forming a piston fitted to a chamber in the valve. This acts as an air cushion, saves the valve seat, and prevents the noise of rapid closing. Loose leather collars, between which the air always exists, form the cushion for the opening movement. When compared to the usual area of air compressor engines, these will appear excessive.

Horizontal blowing engines have long since been out of date, yet simultaneously here are two large machines presented.

Our engine has a tail end bearing. The piston rod is 7½ inches in diameter, and with its own weight and the weight of the blast piston, has a deflection of $\frac{1}{16}$ inch. The slipper referred to and the full width bull ring of the steam piston has to carry this. The stuffing boxes are made to accommodate the spring of the rod. The blast piston is turned ¼ inch smaller than the cylinder, and the brass segmental rings only touch the cylinder.

We think that, with these plans well carried out, there can be no more objection to the horizontal blowing engine than to the ordinary horizontal engine so extensively used, while both possess the same advantages.

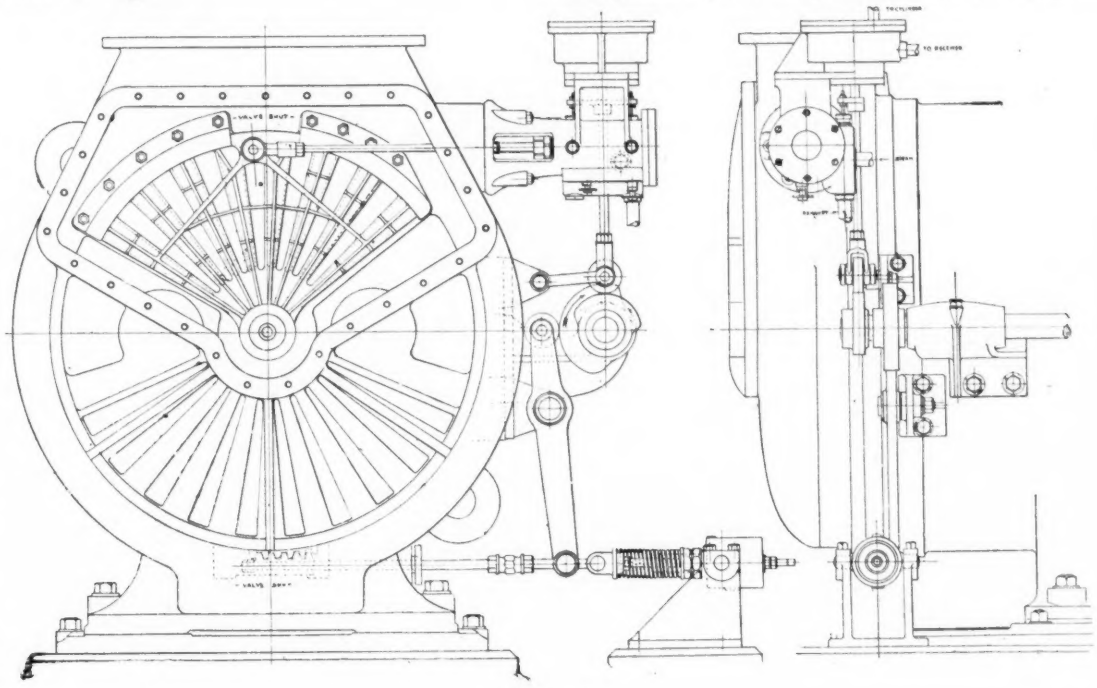


Fig. 1.

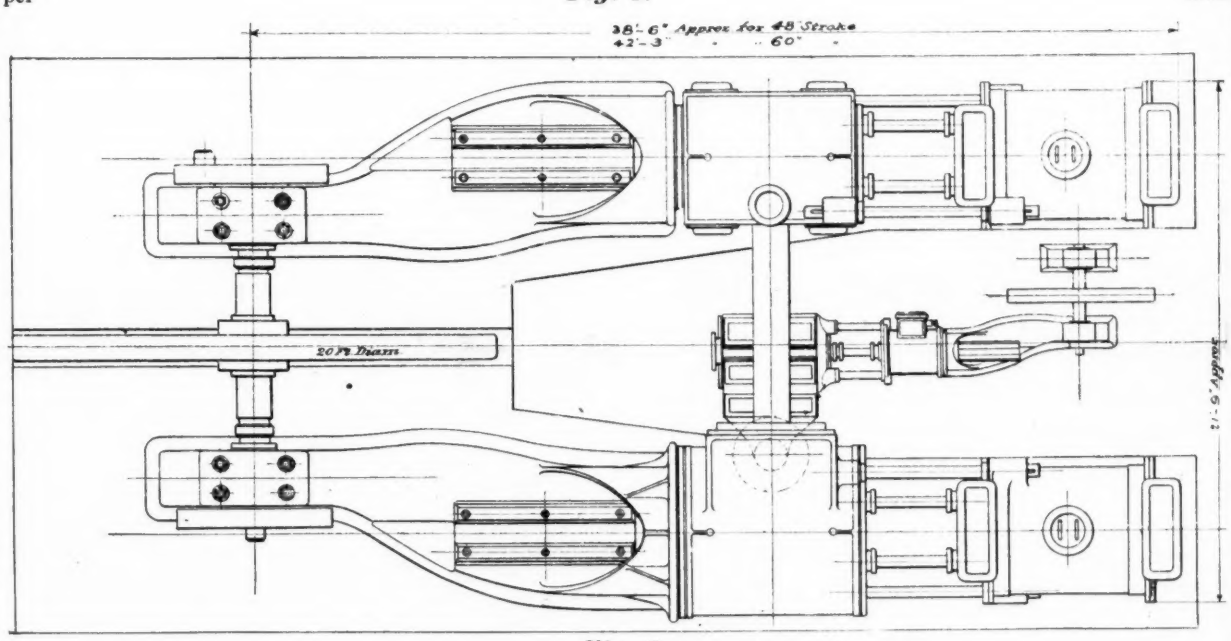


Fig. 2.

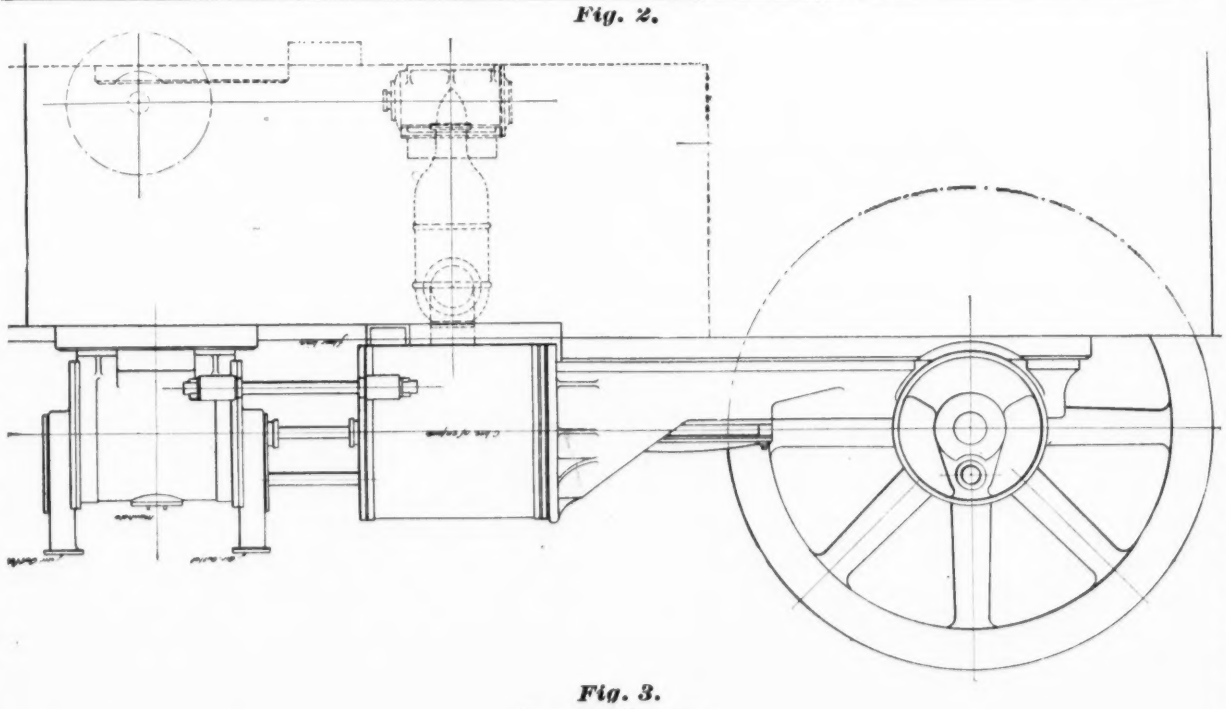


Fig. 3.
BLOWING ENGINES.

JOSEPH MORGAN, JR., Johnstown, Pa.: An existing example of the double horizontal coupled engine is that which the Cambria Iron Company contracted for in 1887, and finished in 1888, for its new Bessemer plant. The builders were the Southwark Foundry and Machine Co., of Philadelphia.

In design it is two horizontal steam engines 48-inch diameter by 72-inch stroke, of Porter-Allen type, coupled at right angles to one shaft. The shaft carries a fly-wheel 22 feet in diameter, and 30 tons in weight. The point of cut-off is regulated by hand levers moving a link block to give the speed and blast pressure needed. Owing to the low pressure (70 to 80 pounds) allowable upon the boilers then in use, the engine was not compounded. Although this would have increased the cost of the engines, yet in building a new plant the amount saved on boilers would make the total cost about the same. I therefore quite agree with Mr. Kennedy that horizontal double compound engines will be the blowing engines of the future.

The blowing cylinders are 60 inch diameter, and 72-inch stroke, and are arranged tandem to steam cylinders. In other words, the general plan is precisely that of the Youngstown engine shown by Mr. Kennedy.

The most novel features of this Cambria engine are the valves. Both inlet and outlet valves are metallic slide valves of grid-iron type and fan shape. The valves are in heads of the cylinders, and are worked by nearly positive mechanism; and after four years' work, having blown 1,100 000 tons of steel in that time, the faces of the valves are in excellent condition and little worn. This is to be attributed to the fact that the motion of the valves takes place at times when they are subject to little or no pressure. Both inlet and outlet valves are so arranged as to lift slightly, in case the actuating mechanism fails, so that no excessive pressure can be produced. The valves were designed by Mr. Good, of the Southwark Co.

The clearance in the air cylinder is about 2 per cent. The high-pressure air current is 93 per cent. of the steam card. The revolutions made in blowing 28 pounds of blast on a 12-ton converter vary from 25 to 40 per minute. With improvements possible in the valve mechanism, 60 revolutions could be easily maintained.

The apparent objection to the horizontal type of engine is its greater wear of piston packing; but with proper construction this is small, and is less than that of the engines ordinarily used to drive rolling-mills. All other considerations favor the horizontal type. As Mr. Kennedy says, it is more stable, more accessible, and cheaper. The steam parts of the Cambria engine show little wear in four years; and the repair cost of metallic blast slide valves is in their favor. As to loss of engine power by breakdown, we have on one occasion uncoupled one side and run the other engine alone at increased speed for a week; and we have repeatedly uncoupled the blast valve actuating mechanism on one end of one blowing cylinder, and run three-fourths of the double engine. To do this we have four stop slide valves on the nozzles of the blowing cylinders.

JAMES C. BROOKS, Philadelphia, Pa.: Owing to the large cost of maintenance of blowing engines for Bessemer and blast furnace purposes, due to the continued crystallization and breakage of the ordinary metal valves used, and the liability to accident from such breakages, also the consequent limited speed of such machines, engineers have given much thought to the design of some device to reduce the repairs and liability to accidents, and at the same time increase the efficiency of engines of this class.

With the exception of the old-fashioned leather flap valve, it has been almost universally the custom to use various modifications of the mushroom valve, which are actuated in one direction by the air pressure and in the other by a spring. To make them tight and protect them from undue jar, various forms of leather and gum

cushions have been used. All, so far as I have been able to learn, require frequent renewal and expensive repairs.

To overcome the liability of breakage these valves have at times been made very small. In doing this the area of the valve openings is greatly reduced, and the conse quent friction raises the temperature of the air very much. For this reason the density of air actually delivered to the cylinder is less than it would be if allowed to enter more freely. Even with the larger valves of this type the tortuous passage of the air as it enters the cylinder creates considera ble friction, and heats the air to a higher temperature than if it had a free passage.

In addition to this, it is impracticable to allow these valves a lift of one-quarter of their diameter, in order to get the full area, without shortening their life very much Furthermore, these valves are very erratic in their movements, and, therefore, the area counted upon is never realized in their operation.

The Southwark Foundry and Machine Company, of Philadelphia, with which the writer is connected, has expended a large amount of money in experiments upon air valve gear, with a view to overcoming the difficulties explained above. They feel that they have succeeded in getting a free passage for the air to and from the tub, and at the same time in making the gear entirely automatic and capable of running at much higher speed than has heretofore been possible. Thus far they have used gridiron valves, so well known in connection with steam engines. They have made them with as many ports as practicable, in order not to reduce the area of the valve opening to such an extent as to have the air affected appreciably by the heated parts of the cylinder head.

In an 84 inch blowing tub they have been able to secure at each end seven large ports for inlet, and a like number for the outlet valves; these ports being of very liberal area, giving an average of 10 per cent. of air piston. They have, however, designs for other styles of valves, upon which they are experimenting with a view to further improvements, if practicable. By having a number of ports it will be understood that the moment the valve begins to open the area is multiplied very fast. Notwithstanding the valve is almost instantly opened the full amount, this feature is an advantage.

Fig. 1 shows the head on the blowing tub of a double horizontal blowing engine, made for the Bessemer plant of the Cambria Iron Company, by the same firm, in 1888. This valve, it will be noticed, is of the fan shaped gridiron type. Under ordinary circumstances this would be subject to criticism, owing to the fact that there would be more wear near its periphery than at its axis, thus leading to leakage; but the design is such that in its operation it lifts from the seat just at the moment it moves, and rests on the back surface until the movement is completed, when it is forced back to its seat by the incoming or outgoing air, as the case may be.

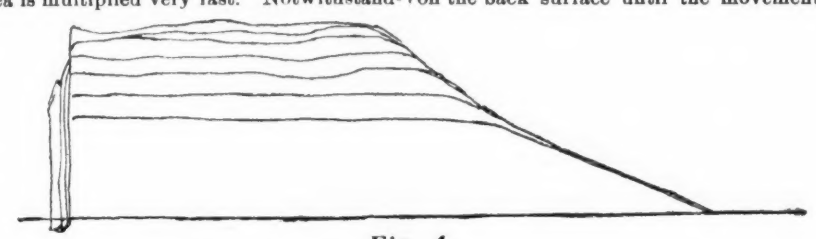


Fig. 4.

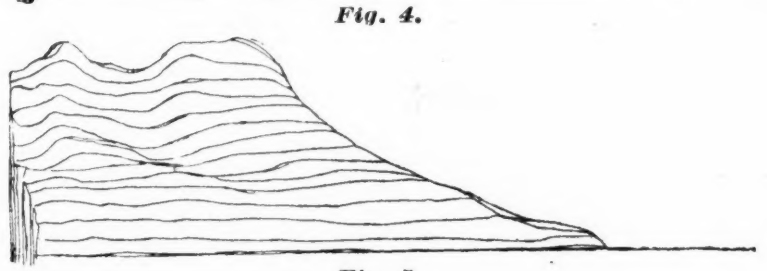


Fig. 5.

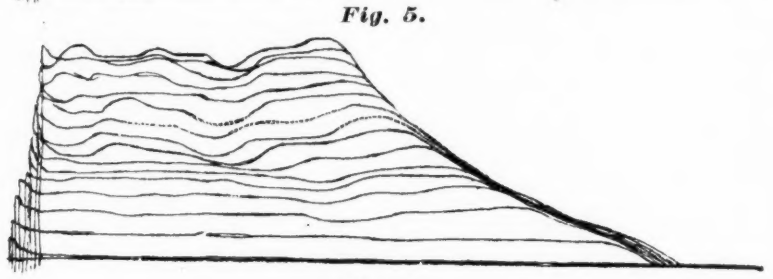


Fig. 6.
Blowing Engine.

The efficiency of this device is shown by the fact that after five years of constant service the wear upon the face of these valves is hardly perceptible. This valve is actuated by steam, applied to the piston of a supplemental cylinder, as shown in Fig. 1. The steam is admitted and shut off from this cylinder by a pilot valve, which in turn is moved by the accumulating pressure in the tub, acting on a differential piston and a cam, alternately.

This vertical differential cylinder is connected on the larger end to the blowing cylinder, and on the smaller end to the receiver. The ratio of this differential piston is proportioned in such a way as to cause it to start the movement of the pilot valves a little in advance of the time at which the piston in the blowing tub arrives at the point where the outlet valve should open. This is done to prevent the building up of a pressure, in advance of the opening of the outlet valve, greater than that in the receiver. This device has accomplished the purpose for which it is designed to the entire satisfaction of the makers and users of this engine. The inlet valve is positive in its movement, and is actuated by a cam, as shown in the figure.

This engine, I understand, has given no more trouble to the users than the ordinary steam engines without the air attachment used about their mill. In other words, it is not necessary for the engine to be overhauled on Sunday in order to have it ready for the next week's work, as is the case with the old style blowing engines. The engine in which the above valves are used is a quarter crank, with steam cylinders 48 inch diameter, air cylinders 60 inch diameter, both 72 inch stroke.

Fig. 2 shows a plan, and Fig. 3 an elevation, of an engine similar to that furnished

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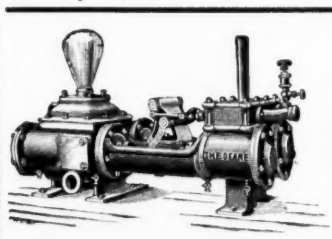

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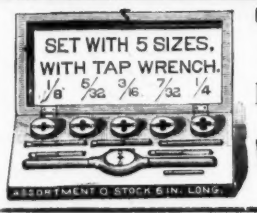

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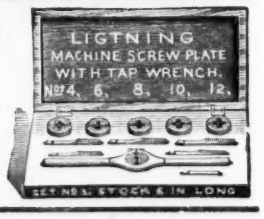

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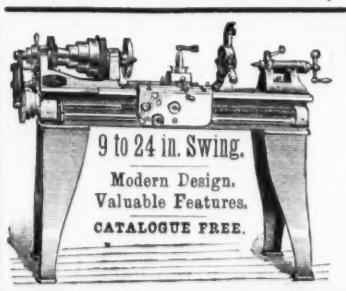

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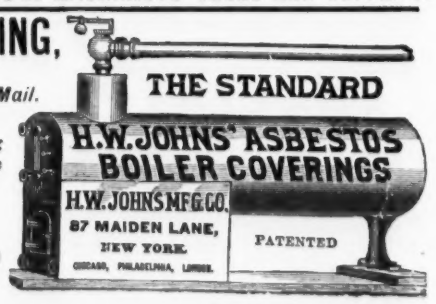

the Cambria Iron Company, with the exception that it is a cross-compound. The steam cylinders are of the well-known Porter-Allen type. This engine can be disconnected, and one side run alone.

I very much prefer horizontal engines, as all the parts are more stable and accessible, and less liable to neglect, owing to the fact that it is so easy to look after oil cups and other parts.

It has been argued by many that the horizontal engine is difficult of maintenance, owing to the wear of the cylinders. In the above case there has been no trouble whatever from this source. The cylinders are in excellent condition, although no tail rods or other devices, frequently thought necessary, have been used.

The above-named company has in operation horizontal tandem compound engines, with low-pressure cylinder 75 inch diameter, 66 inch stroke, running at eighty revolutions as common practice, and at times higher, and after a year's use there are no signs of difficulty with the cylinders.

The air end of the blowing engine mentioned above is entirely automatic. As an interesting exhibit, I insert Figs. 4, 5 and 6. The first is a card taken when starting the engine, with partial pressure in the receiver. It shows that the pressure was built up automatically from the point at which the engine started to the maximum. The two latter shows card taken with no pressure in the receiver at the start. They illustrate the automatic building up of the pressure from the atmosphere to maximum.

In explanation of the apparent distortion of the above diagrams, I would say that the cards were not superposed, owing to the fact that the string stretched as the speed increased, and in opposite directions—the indicators being one right and one left. Each of the various diagrams, when considered separately, shows the absolutely automatic action of the valve.

MANUFACTURES.

Poole, Roche & Co., Whittenton, Mass., will resume operations.

The Montague Paper Co., at Turner's Falls, Mass., is adding new machinery.

The Smelting Works at Portland, Me., has resumed work permanently.

L. V. Boyle & Co., of Chicago, will establish a saw-mill and box factory at Rosedale, Miss.

The burned tinware factory at Louisville, Ky., of Stratton & Terstagge, will at once be rebuilt.

The New Haven (Conn.) rolling-mill has started up again after six weeks' idleness, with 150 men.

T. B. Willis & Co. have leased the Monroe (N. C.) Foundry and Machine Works and will operate it.

Operations have commenced on the foundation for the new B. & A. shops at West Springfield, Mass.

The W. Dewees Wood iron plant at McKeesport, Pa., has started up. About 500 men are employed.

The Moundsville (W. Va.) Mineral Company will at once rebuild its burned mineral wool manufactory.

The keyboard factory and ivory works of Comstock, Cheney & Co., Essex, Mass., have resumed business.

A compound engine of the tandem type is to be added to the Ives Johnson Co.'s plant at Fitchburg, Mass.

The Malleable Iron Mfg. Co. has been formed at Columbus, O., with $25,000 capital. Incorporators, R. T. Houk and others.

The Rotary Engine Co. is among the latest to form in Chicago. Capital, $100,000. Incorporators, Wm. Smith and others.

There has been formed The Rochester (N. Y.) Hardware Co. with capital $10,000, and Directors T. T. Smythe and others.

A. G. Rhodes and others have formed at Atlanta, Ga., the Rhodes, Snook & Haverty Furniture Co. The capital stock is $30,000.

The Edward S Clark Co. has been organized at Kittery, Me., for the purpose of building steam yachts, with $30,000 capital stock.

Twenty-five men who were laid off at the W. N. Y. & P. car shops, Orlean, N. Y., several months ago, owing to dull times, are at work again.

The Scottdale (Pa.) Iron and Steel Co. has signed the Amalgamated Iron and Steel Workers' scale, and the 400 employes have returned to work.

The Sampson Mfg. Co. has been chartered in Hartford, Conn., to manufacture machinery. Capital stock $10,000. Directors, C. F. Doebler and others.

Among the recent concerns to incorporate is the Imperial Ball-Bearing Axle Co., Chicago; capital, $10,000. Incorporators, Edw. E. Elliott and others.

The Bachelder Mfg. Co.'s plant, Wallingford, Vt., which has been idle for many years and was formerly used for the manufacture of forks, has been sold to local parties who contemplate utilizing it for the manufacture of lasts and possibly axes, etc. This property originally cost over $100,000, and was sold for $12,000 a few days ago.

The Hartford Dredging Company has the contract for dredging a channel to connect the Great Salt Lake on Block Island with the Atlantic Ocean. The channel will be 400 feet long and 15 feet deep, and as the water in the lake is from 25 to 60 feet deep, it will form an artificial harbor of great benefit to the island. The State of New York has appropriated $25,000 for the construction of the channel, and the town of Shoreham a like amount. The work will be begun as soon

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$85.00 for an Indicator when you can get either of these for $40.00, packed in finest cases, finest workmanship, finest material, and the best designs.
Send for circular of Reducing Wheels, Planimeters, Three-Way Cocks and 25 other high grade specialties.
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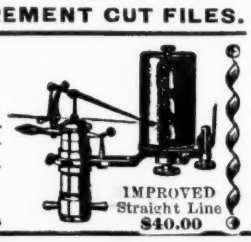

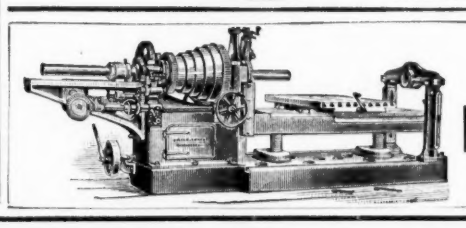

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Improved Patterns! Late Designs!

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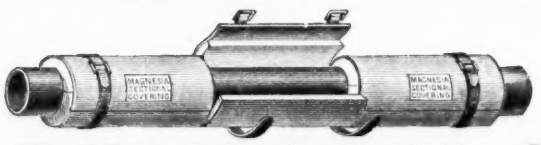
Sectional Steam Pipe and Boiler Coverings.
ABSOLUTELY FIRE-PROOF.



THE GREAT COAL SAVER

MANUFACTURED BY
THE KEASBEY & MATTISON CO.
CINCINNATI: 114 West Second Street.
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Robert A. Keasbey, New York 54 Warren St.
S. C. Nightingale & Childs, Boston, 134 Pearl St.
Macan & Co., Philadelphia, 1420 Callowhill St.
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Wm. B. Morgan, Washington, Builders' Ex'e
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Symmes & Co., Memphis, 192 Front St.

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F. Sprinkman, Milwaukee, 133 Sycamore St.
W. W. Hite & Co., Louisville, 176 Fourth St.
F. Boecler, St. Louis, 108 Walnut St.
S. P. Conkling, Detroit, 20 Atwater St., East.
C. W. Badgley & Co., Denver, 18th & Market Sts.
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FITCHBURG MACHINE WORKS,
MANUFACTURERS OF
FITCHBURG MODERN
AND OTHER
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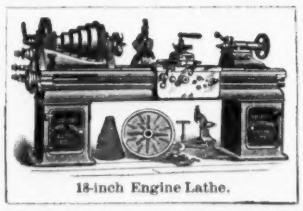
18-inch Engine Lathe.

THE CELEBRATED
ENGINE LATHE
METAL-WORKING MACHINES
FITCHBURG, MASS.

BUILDERS IRON FOUNDRY,
FOUNDERS AND MACHINISTS,
PROVIDENCE, R. I.
Orders are solicited for machine work requiring accurate workmanship and large machine tools. Our equipment is probably superior to that of any shop in New England, employed chiefly for contracts or general jobbing. Small, as well as large orders receive careful attention, and we are prepared to assist machine shops which have tools smaller than our own.

COOKE & CO.,
163 & 165 WASHINGTON ST.,
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ENGINES and BOILERS.

VERTICAL,
HORIZONTAL,
STATIONARY,
PORTABLE,
Plain and Automatic.
Write fo. Catalogue and mention this paper.

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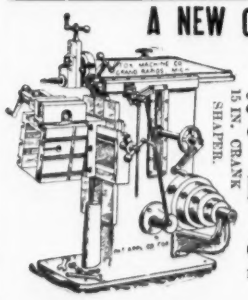
INDUSTRIAL PUBLISHERS, BOOKSELLERS AND IMPORTERS,
810 Walnut St., Philadelphia.
Our New and Revised Catalogue of Practical and Scientific Books, 88 pages 8vo., and our other Catalogues and Circulars, the whole covering every branch of Science applied to the Arts, sent free and free of postage to any one in any part of the world who will furnish his address.

A NEW CRANK SHAPER.



NOVEL, YET SIMPLE.
Length of stroke changed INSTANTANEOUSLY while IN MOTION.
Get Photos & Prices.
NOTHING LIKE IT.
Fox Machine Co.,
325 Nor. Front St.,
Grand Rapids, Mich.
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P.H.& F.M.ROOTS,
Connersville, Indiana.
Chicago Office, 1405-10 Manhattan Building.
MANUFACTURERS OF
PORTABLE FORGES, TUYERE IRONS, ETC.

ROOTS' NEW ACME HAND BLOWERS
Slow speeded, Force-blast, Durable, Compact and Cheap.
Roots' Foundry Blowers, Gas Exhausters, etc.
S. S. TOWNSEND, Gen. Agt. } 163 & 165 WASHINGTON ST.,
COOKE & CO., Selling Agts. } NEW YORK.
In Writing, Please Mention This Paper.

WORTHINGTON CONDENSERS.
ACCRECATING IN CAPACITY
276,320
HORSE POWER
ARE NOW IN USE.
SEND FOR SPECIAL PAMPHLET.
HENRY R. WORTHINGTON,
NEW YORK, 86 and 88 Liberty St.
BOSTON, 70 Kilby St.
PHILADELPHIA, 607 Arch St.
CLEVELAND, 24 South Water St.
CHICAGO, 185 to 189 Van Buren St.
ST. LOUIS, Eighth and St. Charles Sts.

as the dredging machine can be taken over to Block Island, and it will require eight months to complete it.

Superintendent Dunstan, of the Central Copper Mine Company, in Kewaunee County, has received orders from the directors in Boston to abandon the mine. This closes a forty year term of continuous operation of this mine, during which it has returned to its stockholders $2,000,000 in dividends on an investment of $100,000. The shutdown is due to the utter exhaustion of the vein and the failure to find other deposits on the company's property. Four hundred men, wholly dependent upon the mine, are out of employment.

The Birmingham (Conn.) Iron Foundry has awarded the contracts for the erection of a new foundry building for the concern on the land recently purchased from the Peck, Stowe & Wilcox Company, and lying directly south of the company's present buildings in Derby. The new building will be a substantial brick structure, with an iron roof. The main building will be 168x76½ feet, with an ell to take in the cupolas, cupola staging and core room. The roof will be a very strong one, covered with 2-inch planking and slate. D. H. Austin has received the contract for putting up the foundations, and S. E. Gesner for the brick work and roof covering, and all the other work, except the iron truss roof, the contract for which has been awarded to J. E. Buddington, the builder of the Ansonia bridge. Work will be begun at once on the building, which is to be completed by the middle of October. The company, in fitting up the new foundry, will put in six 15 ton power cranes, a hydraulic elevator for handling coal and iron, new roll pits, core ovens and scales. This improvement will be one of which the public will be glad to learn as it will largely increase the facilities of the foundry.—*Ansonia Sentinel.*

Machinists' Supplies and Iron.

New York, August 4, 1894.

Iron—American Pig—We quote standard brands, $12.50 to $13 for No. 1; $11 to $12 for No. 2. Southern brands, $11 50 to $12.25 for No. 1; $10.50 to $11 for No. 2; $10 to $10 25 or No. 3; $10.50 to $11 for No. 1 soft; and $10.25 to $10.75 for No. 2 soft. Foundry No. 4, $9.75 to $10 25.

Antimony—We quote L. X., 8¾c. to 8⅝c.; Cookson's, 9¾c to 10c.; Hallett's, 8.25c. to 8.50c; and U. S. French Star, 10c.

Lard Oil—We quote 55c. to 57c., according to quantity.

Copper—There is no change of any importance in the market. Offers are more plentiful at slightly lower prices Consumption is very light. Lake Copper is quoted at 9½c., but 9.10c. will buy. Casting Copper is held at 8.60c. Lower prices are looked for.

Lead—The market is firm. For spot lead, New York delivery 3.65c. to 3.70c. is quoted.

Spelter—The market is weak. Spot is quoted at 3 45c., New York delivery.

Tin—There is no improvement in the market. Buyers buy only for immediate demand. For spot 18.80c. is asked.

✲WANTED✲

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Young mach. wishes sit., steady & good worker, m'ber I. A. of M., D. C. Springer, New Haven, Pa.

Wanted—By a German engineer and draftsman a position. Box 130, American Machinist.

Draftsman, tech., with shop practice, wants pos., best references. E. L., 3413 3d Ave., New York.

Wanted—Foreman for drawing-room of a large mfg concern in the mechanical engineering line. Address Box 127, American Machinist.

Wanted—A competent man to take charge of a small but complete plant for manufacturing elevators. Box 129, American Machinist.

A mechanic with experience in designing special tools, etc., wants position as general foreman or asst. supt., age 36. Box 131, American Machinist

Mechanical draftsman, technical education, and experience in both drafting room and shop, wants position. Address Box 134, American Machinist.

Wanted Pos by young mech. draftsman, 6 years' exp. Heavy machine tools, printing mach'y and gen. mach'y, 1st class refs. W., Am. Mach

Wanted—Position by steady molder of ability, expd. on heavy eng. work, general jobbing, ship work, etc., green, dry or loam. Box 135, Am. Mach.

Situation wanted by a toolmaker, experienced in designing dies and chucking machine tools for the manufacturing of bicycles. Box 136, Am. Machinist.

Draftsman and vise hand, have experience in designing haulage machinery, wishes position in drawing room or shop. A B., 15, Am. Machinist.

Wanted—Young man to organize piecework system in an engine shop, should be thorough mechanic. Address, with exp., K., Am. Machinist.

Man experienced on printing and folding machinery; understanding character of same, design and manufacture, and capable of producing economically, seeks position. Artificer, Amer. Mach.

Wanted—Foremanship in small machine shop by young machinist with experience in shop and drawing-room of tool works. Up in latest practice. Philadelphia preferred. Box 132, Am. Machinist.

First-class mech. eng. and draftsman, expert in iron and steel works and mining mach'y, in steam, hydraulic and gen. eng'g & structural work, wants responsible pos., moderate terms. "All Around." American Machinist.

Wanted—A man thoroughly acquainted with the Jones & Lamson turret lathe; one who can work the machine to its full capacity. To such a man, steady employment can be given. Address Taunton (Mass.) Locomotive Mfg. Co.

Wanted—Pos. as supt., asst. supt., chief engineer or chief draftsman by member A. S. M. E., 15 years experience in design, manufacture and operation of Corliss & automatic engs., ice & rig. machines, dynamos & electric mac'ls & mod. electric power plants, best refs. Engineer, Box 128, Am. Mach.

Wanted—An experienced salesman to sell strictly high-grade tool steels in Pittsburgh, St. Louis and intermediate points. Only one who can give first-class references, and can command a good trade in those markets need apply. Address Box 133, care American Machinist.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S.M.York,Clev'd,O.

Best Steel Flue Scrapers. Kelley Co., Erie, Pa.

Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Co., Cincinnati, O.

Light and fine machinery to order; Foot Lathe Catalogue for stamp. E. O. Chase, Newark, N. J.

Wanted—To buy good second-hand tools. Box 83, American Machinist.

Manufacturer wanted for a well-known line of standard medium weight machinery. Must be good work and within two hours of New York. F P., care of American Machinist.

Do you want a picture of the famous Locomotive "999?" Send 50 cents for our fine copper plate *transparent* picture (14x28), showing all parts *inside* and *outside*, all named and numbered, on satin gloss paper, for framing, educational, beautiful, correct. Locomotive Engineering, 256 B'way, N.Y.

Established in 1874.

CLEVELAND TWIST DRILL CO.

COR. LAKE & KIRTLAND STS. CLEVELAND, O.

100 & 102 Reade Street, New York.
85 Queen Victoria St., London, Eng.
5 Neue Promenade, Berlin, C., Germany.

DETROIT TWIST DRILL CO., DETROIT, MICH., U. S. A.

SOLE MANUFACTURERS OF

GRAHAM'S GROOVED SHANK TWIST DRILLS AND CHUCKS.

Endorsed by Practical Mechanics Everywhere. Send for Catalogue.

SECOND-HAND MACHINE TOOLS,

Boiler Tools and Steam Hammers

Now remaining unsold in the Engine and Boiler Works, will be sold very low before removal.

IRON PLANERS.
19 in. x 3 ft. Wheeler.
20 " x 4 " Lathe & Morse.
24 " x 4 " Wood & Light.
24 " x 5 " New Haven.
26 " x 7 " N. Y. S. Eng. Co.
30 " x 10 " Pease.
35 " x 7 " Hewes & Phillips.
36 " x 8 " Pease.
60 " x 24 " Heavy Pattern.

SHAPERS.
8 in. Stroke Gould.
16 " " Gould & Eber.
22 " " Triple Geared.

DRILLS.
25 in. Swing, Prentice complete.
26 " " Prentice Friction.
40 " " Cinti, complete.
48 " " Old Style.
Radial Drill, 86 in. complete.

MILLING MACHINES.
Brown & Sharpe No. 6 Plain.
Brainerd No. 15, Universal.
Garvin No. 3 Bk. Gears auto. fd.

BORING MILLS.
Bement No. 2 Hor., B. & D.
Bement Cyl. Borer, for Cylinders 10 to 30 in.
Upright B. & T. Mill, 38 in.
Pond Upright B. and T. Mill 6 ft.
B. & S. Upright Turret Borer.

ENGINE LATHES.
13 in. x 6 ft. Blaisdell.
14 " x 6 " Reed.
15 " x 5 " Pond.
16 " x 6 " New Haven.
16 " x 6 " Ames.
18 " x 8 " Putnam.
20 " x 10 " Fitchburg.
22 " x 8 " Harrington.
24 " x 12 " Putnam.
30 " x 10 " Prentiss, Taper.
35 " x 15 " Hewes & Phillips.
36 " x 24 " Old Style "cheap."
36 " x 17 " Ferris & Miles.
48 " x 17 " Hewes & Phillips.

HAMMERS.
50 lb. Helve, Bradley, Up'g't.
300 " Steam, Ferris & Miles.
800 " " "
1200 " Drop with Lifter, Farrel F'd'y's Make.

BOILER TOOLS.
Rolls, 6, 8 and 10½ ft.
Hor. Flange Punch, "H. and J."
Flange Clamps, 6 ft
Bement Plate Planer, 16 ft.

MISCELLANEOUS.
Acme, 3½ in. Bolt Cutter.
Slotters 10 and 18 in. Stroke.
Putnam Tool Grinder.
Screw Machine, 2 in. hole.
Hand Jib Crane, "Cheap."
Allen Port Riveting Mach.

J. J. McCABE,

SUCCESSOR TO E. P. BULLARD'S N. Y. Mach'y Warerooms.

14 Dey St., NEW YORK.

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10 in. Post Drill.
10 " " Auto. Feed to Table for Butt Drilling.
1, 2 and 3 Spindle Sensitive with and without Power Feed.
2, 3 and 4 Spindle Gang Drills.
20 24, 26, 28, 30 and 44 in. "
30 in. Swing Post Drill.
5 ft. Arm Radial Drill.
12 in. Stroke, 16 in. x 16 in. Crank Planer.
16 in. x 4 ft. Planer.
24 " 4, 5 and 6 ft. Planer.
28 " 5 and 8 " "
30 " 5, 8 and 10 " "
60 " 20 " "
72 " 25 " "
9, 12, 16 24 and 26 in. Stroke Shaper.
10 in. Stroke Slotter.
Hyd. Riveting Machine.
Crane, Both A1.
Punch and Shear.
Plate Planer.
11 in. x 5 ft. Eng. Lathe.
14 " 6 " " "
15 " 6 and 8 ft. Eng. Lathe.
16 " 5 6, 7 and 10 ft. Eng. "
18 " 6 7 and 8 " " "
20 " 5, 6, 7, 8 and 10 ft. " "
21 " 10 and 13½ ft. " "
24 " 13 " " "
25 " 16 and 24 " " "
26 " 10½ " " "
32 " 16 " " "
35 " 13 " " "
52 " 35 " " "
57 in. Double Head Driving Wheel Lathe.
Bement Car Axle Lathe.
1¼ & 2 in. Bolt Cutter Schenk's.
7 Spd'l Nut Tapper, Dunel.
2 Spd'l Profiler, No. 1 P. & W.
No. 1, 2 and 2½ Screw Machs. P. & W.
No. 1 Lincoln Pattern Miller.
Hand Millers, Screw Slotters, Mill and Cutter Grinders.

Lot of Miscellaneous Machinery, Engines, etc. Send for Latest List.

GEO. PLACE MACHINE CO.,

Offices: 145 BROADWAY and 86 LIBERTY ST.

Warehouse: 511 and 513 WEST 13th STREET,

NEW YORK.

The "Eclipse" Drill, Tool and Graver Sharpener.

The only practical device for the re-sharpening of drills or any other tools requiring a flat surface and fine edge. It can be adjusted to any angle, and by aid of the degree or index marks the drill or tool can be set to the desired angle almost instantly.

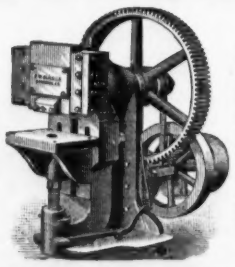
Price, Size A $1 75, sent post paid on receipt of price.

EZRA F. BOWMAN & CO.,
22 E. Chestnut St., Lancaster, Pa.

E. W. BLISS CO.

1 ADAMS ST., BROOKLYN, N. Y.

Chicago Office, 100 W. Washington Street.



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DROP HAMMERS, SHEARS AND SPECIAL MACHINERY.

The STILES & PARKER PRESS CO.

TOOLS FOR SHEET METAL WORK,

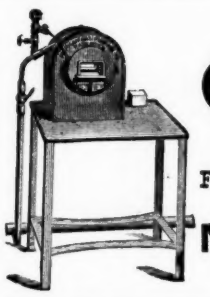
Niagara

PRESSES, DIES, TINNERS' TOOLS, SHEARS,

NIAGARA STAMPING AND TOOL CO.,

BUFFALO, N. Y.

AMERICAN GAS FURNACE CO.,



OIL GAS PLANTS

GAS BLAST FURNACES and HIGH PRESSURE BLOWERS

For the economical generation and systematic application of HEAT.

CATALOGUES ON APPLICATION.

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English Agency:

Chas Churchill & Co., Ltd., 21 Cross St., Finsbury, London, E. C., England.

SECOND-HAND MACHINE TOOLS.

ENGINE LATHES.
13 in. x 5 ft. Phenix.
14 " x 6 " Bogart.
15 " x 6 " Blaisdel.
15 " x 8 " Fitchburg.
16 " x 6 " Perkins.
16 " x 7 " Bement.
16 " x 6 " F. E. Reed.
18 " x 6 " New Haven
18 " x 8 " Pease.
18 " x 8 " Blaisdel.
18 " x 10 " "
20 " x 6 " Bullard.
20 " x 12 " Fifield.
30 " x 12 " Blaisdel.
37 " x 14 " Old Style.

PLANERS.
22 in. x 22 in. x 4 ft. L. W. Pond.
24 " x 24 " x 6 " Whitcomb.
24 in. x 24 in. x 10 ft. Pease Planer Co.
28 in. x 28 in. x 7 ft. New Haven.

SHAPERS.
10 in. Juengst Crank.
10 " Wood and Light Traverse Head.
15 in. Juengst Crank.
18 " Putnam Traverse Head.

DRILL PRESSES.
10 in. Milliken Bench.
10 " Gardam Sensitive.
10 in. Slate, 1 Spindle.
10 " 3 Spindle, Slate.
No. 1 2 Spindle, Garvin.
" 2 3 " "
" 3 4 " "
" 3 6 " "
20 in. Barnes.
20 " Blaisdel.
24 " "
5 ft. Niles Radial.
7 ft. Alfred Box Universal Radial.
9 ft. Holly Mfg. Co., Radial

SCREW MACHINES.
No. 1 Garvin.
" 5 Brown & Sharpe.
" 2 Garvin.
" 2 Warner & Swasey.
" 3 Windsor Machine Co.
" 2 ½ Pratt & Whitney.
" 3 Garvin.
16 in. x 5 ft. Flather & Co.
18 " x 6 " Hendey Mche. Co.

MILLING MACHINES.
No. 2 Garvin, Hand.
" 11 " Power.
" 12 " "
" 0 " Universal.
" 5 Brainerd, Stan'd Univ.
" 3 " "
" 2 Garvin, Lincoln.
" 4 " Rack Feed.
Garvin Heavy Slab Miller.

Also, a large number of other machines. Write for complete list and detailed description.

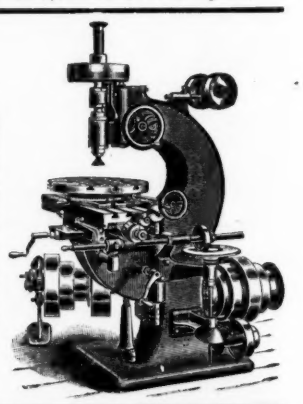
THE GARVIN MACHINE CO.,

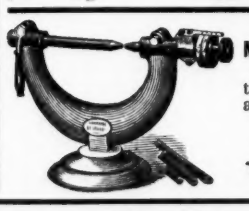
LAIGHT & CANAL STS., NEW YORK.

Also 51 North 7th St., Philadelphia, Pa.

THE BECKER MILLER No. 4

MANUFACTURED BY JOHN BECKER MANUFACTURING CO., FITCHBURG, MASS.





SWEET'S Measuring Machine.

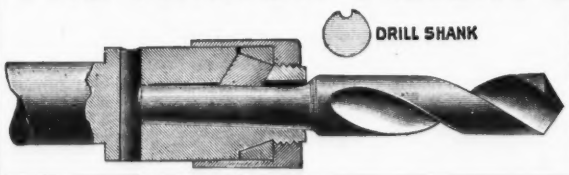
The only micrometer that will not lose its accuracy by wear.

Satisfaction Guaranteed,

SYRACUSE TWIST DRILL CO.,

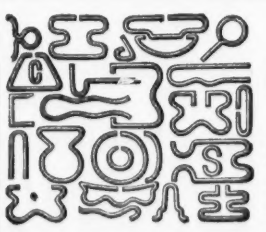
Syracuse N Y

The Andrew Patent Drill Chuck.



The original (not copied) device to prevent twisting off Tangs. No extra cost for ANDREW'S reverse incline groove in the shanks. Chucks made direct on new or old spindles. Holds heavy taper-shank tools from dropping out. Best Practical Chuck in the World. Endorsed by all prominent Twist Drill Makers and Mechanical Experts. Send for catalogue.

M. L. ANDREW & CO.,
CINCINNATI, OHIO.



BLAKE & JOHNSON,

WATERBURY, CONN.

Builders of WIRE FORMING MACHINES

With F. B. Manville's Patent Sliding Former,

For making articles from the coil, of either round, half-round, flat, or square wire, similar in shape to those shown in the cut herewith. Also similar articles made to order.

Send samples of articles required, and mention quantity wanted, that we may quote prices for either machine or the goods, whichever may be desired.

☞ Bicycle and Labor Saving Machinery a Specialty.

STEEL BALLS

For all Anti-Friction Purposes.

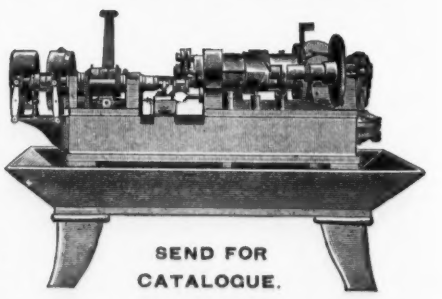
WE ALSO MANUFACTURE

AUTOMATIC SCREW MACHINES AND SCREW MACHINE PRODUCT

OF EVERY DESCRIPTION.

Cleveland Machine Screw Co.,

CLEVELAND OHIO.



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THOS. H. DALLETT & CO.,
YORK ST. & SEDGLEY AVE., PHILADELPHIA.
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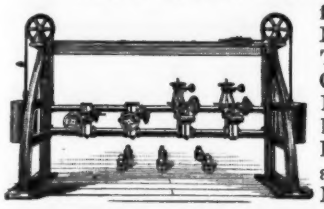

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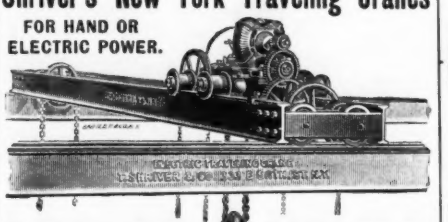

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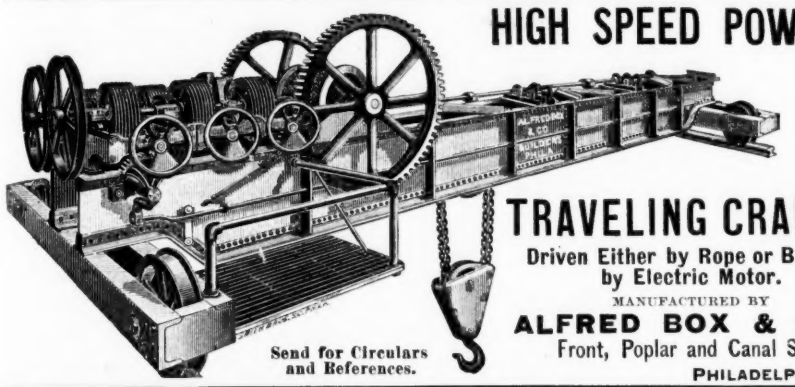

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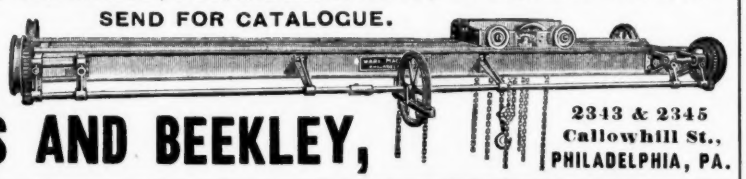

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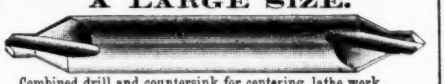

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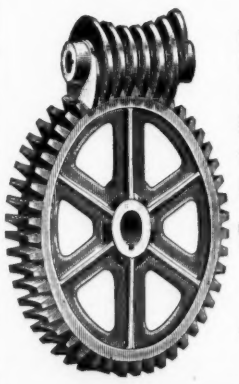

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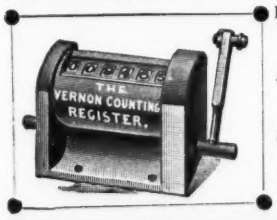

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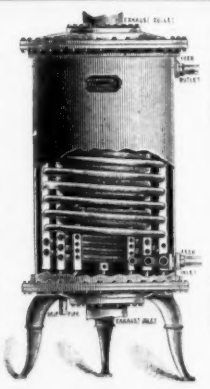

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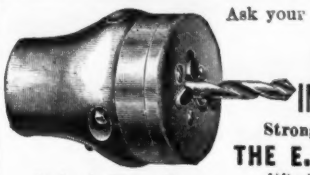

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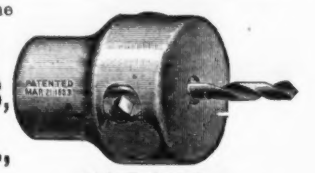

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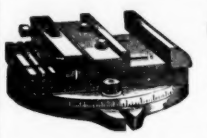

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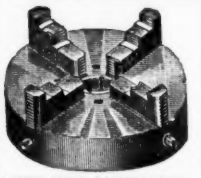

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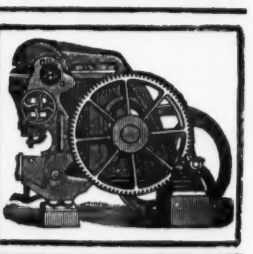

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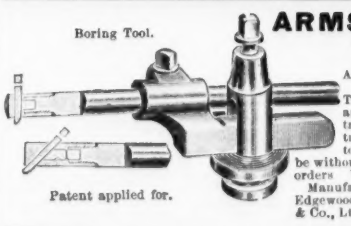

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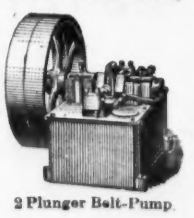

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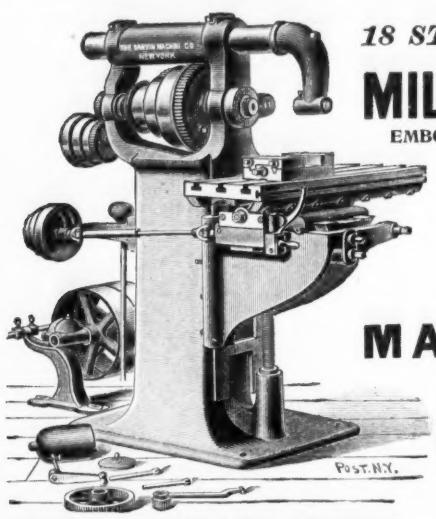

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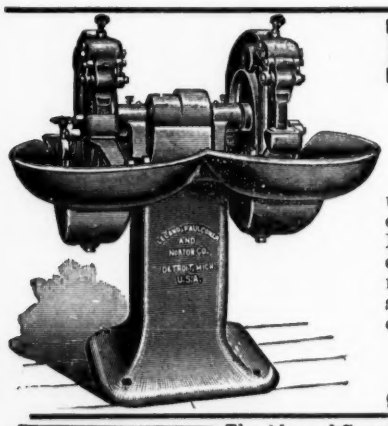

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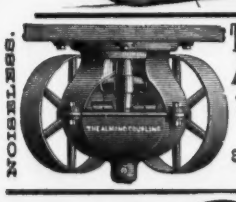

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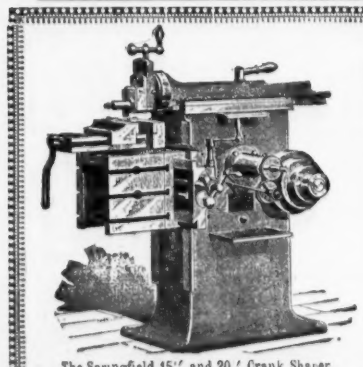

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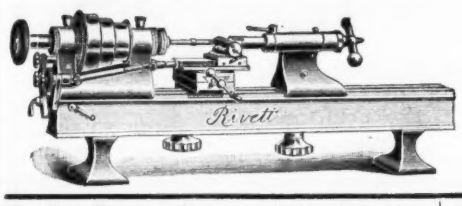

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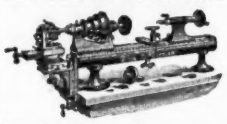

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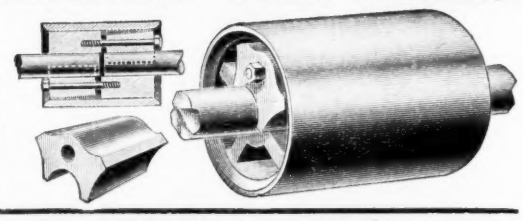

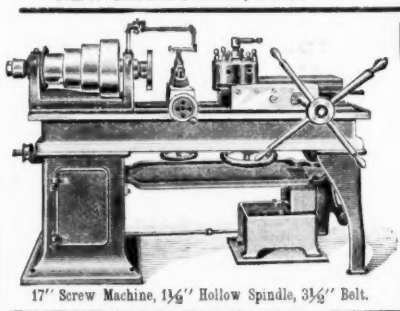

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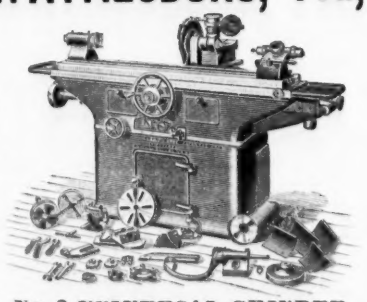

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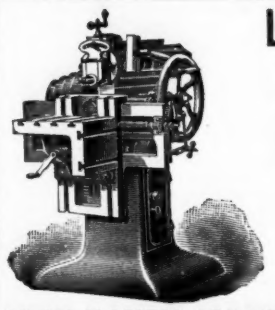

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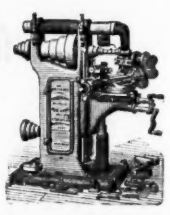

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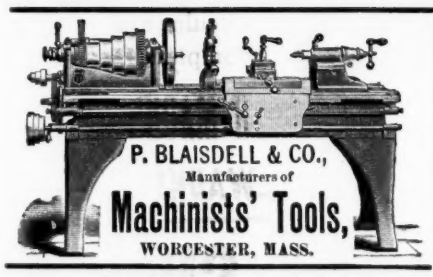

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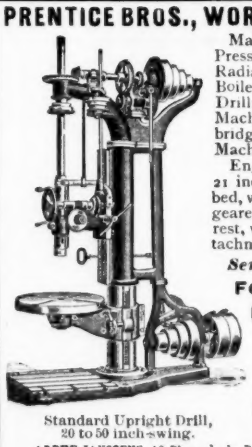

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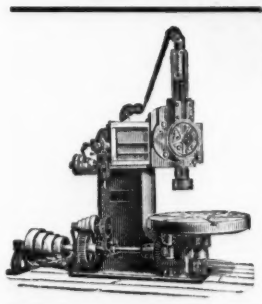

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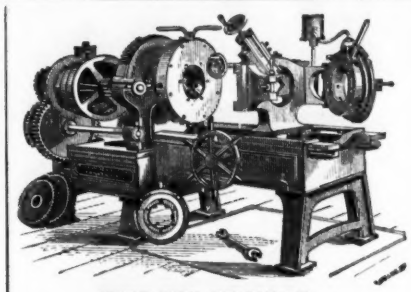

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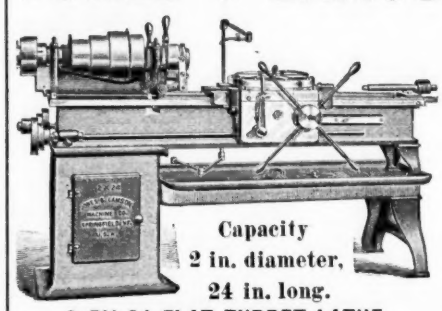

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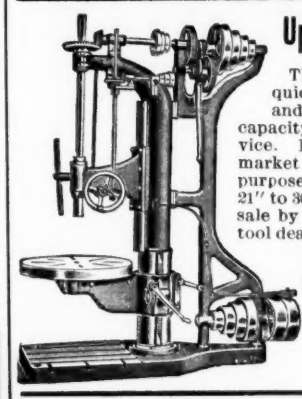

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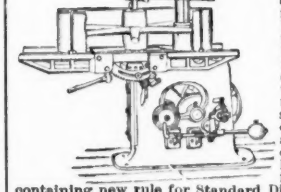

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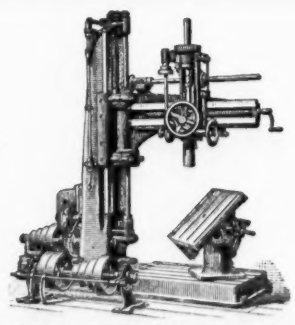

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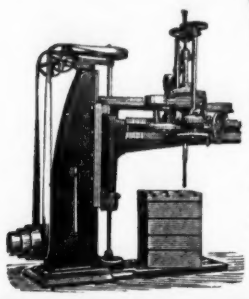

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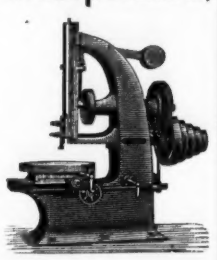

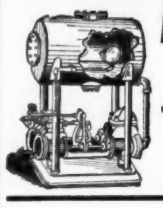

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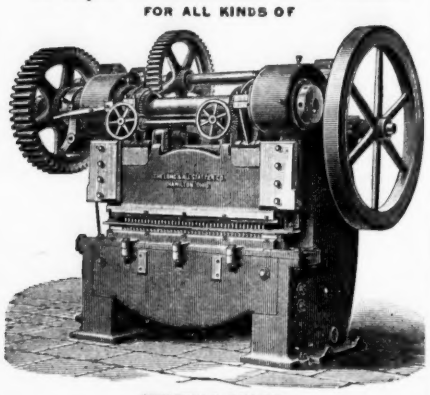

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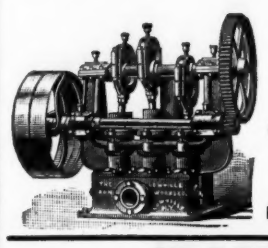

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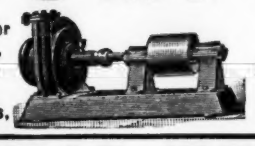

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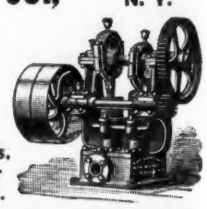

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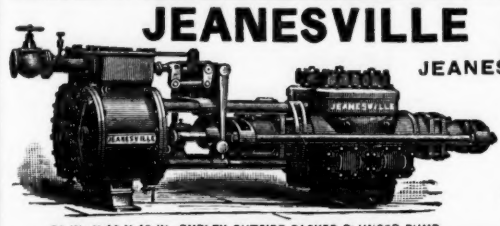

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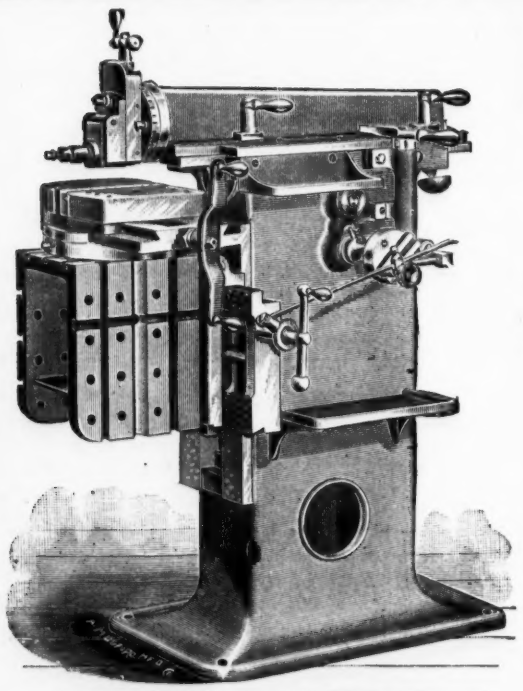

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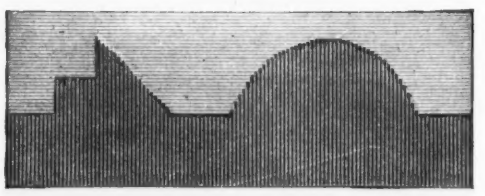

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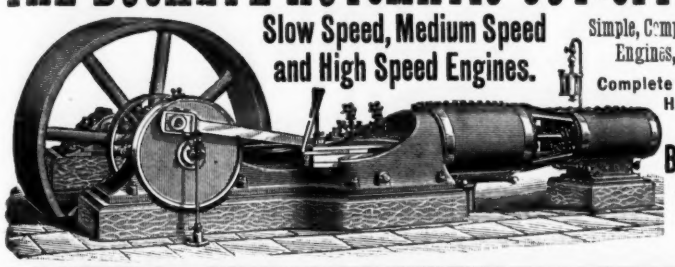

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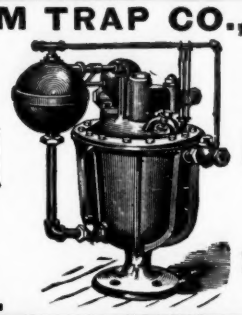

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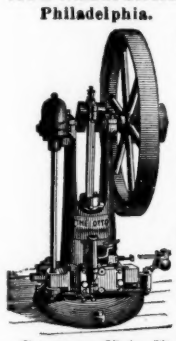

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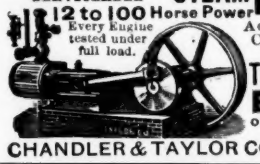

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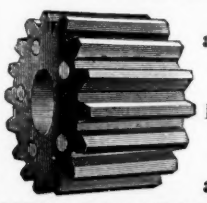

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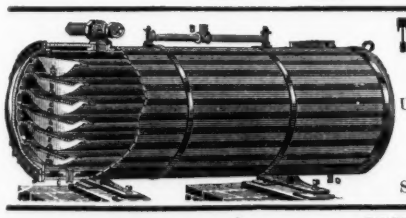

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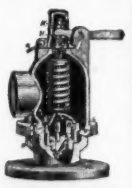

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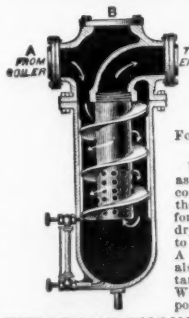

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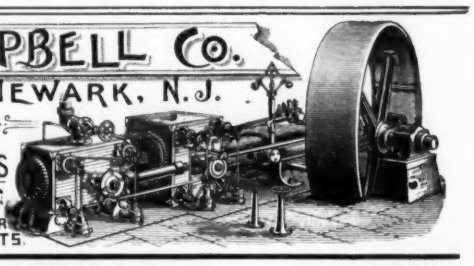

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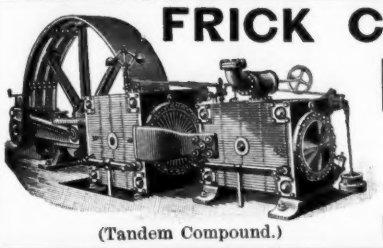

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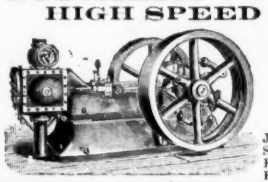

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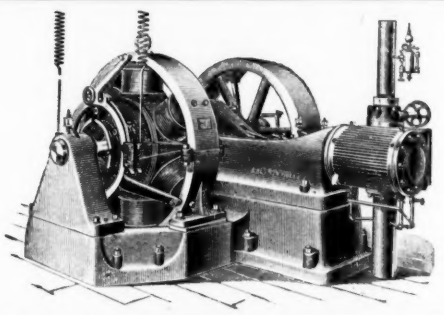

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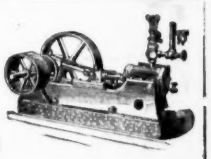

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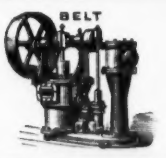

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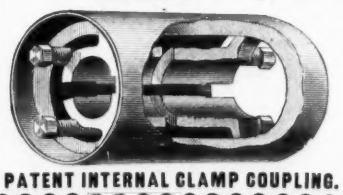

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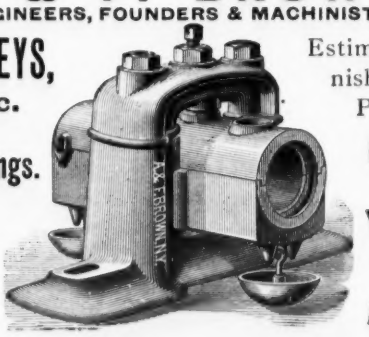

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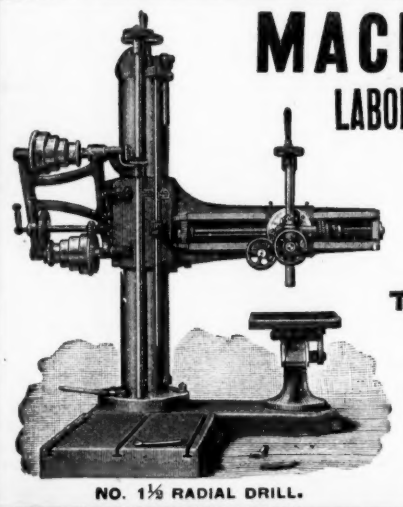

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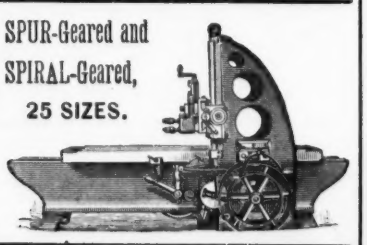

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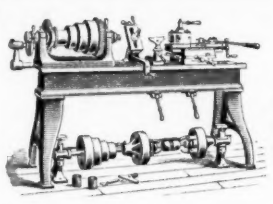

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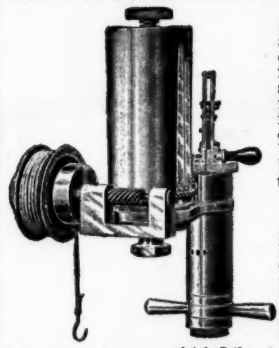

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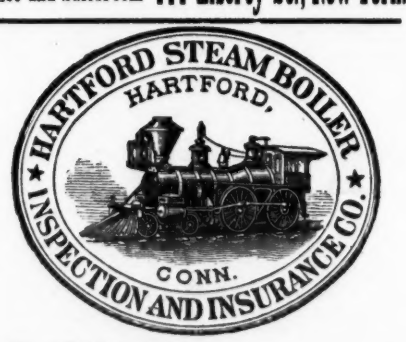

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